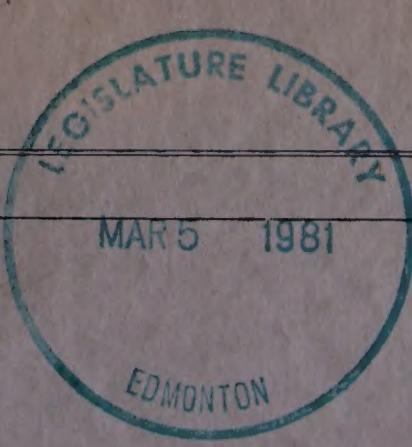


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# The Province of Alberta

## PETROLEUM AND NATURAL GAS CONSERVATION BOARD

IN THE MATTER OF THE GAS RESOURCES PRESERVATION ACT

AND IN THE MATTER of a Joint Hearing to determine various questions  
relating to the proposed Export of Natural Gas from the Province of Alberta.

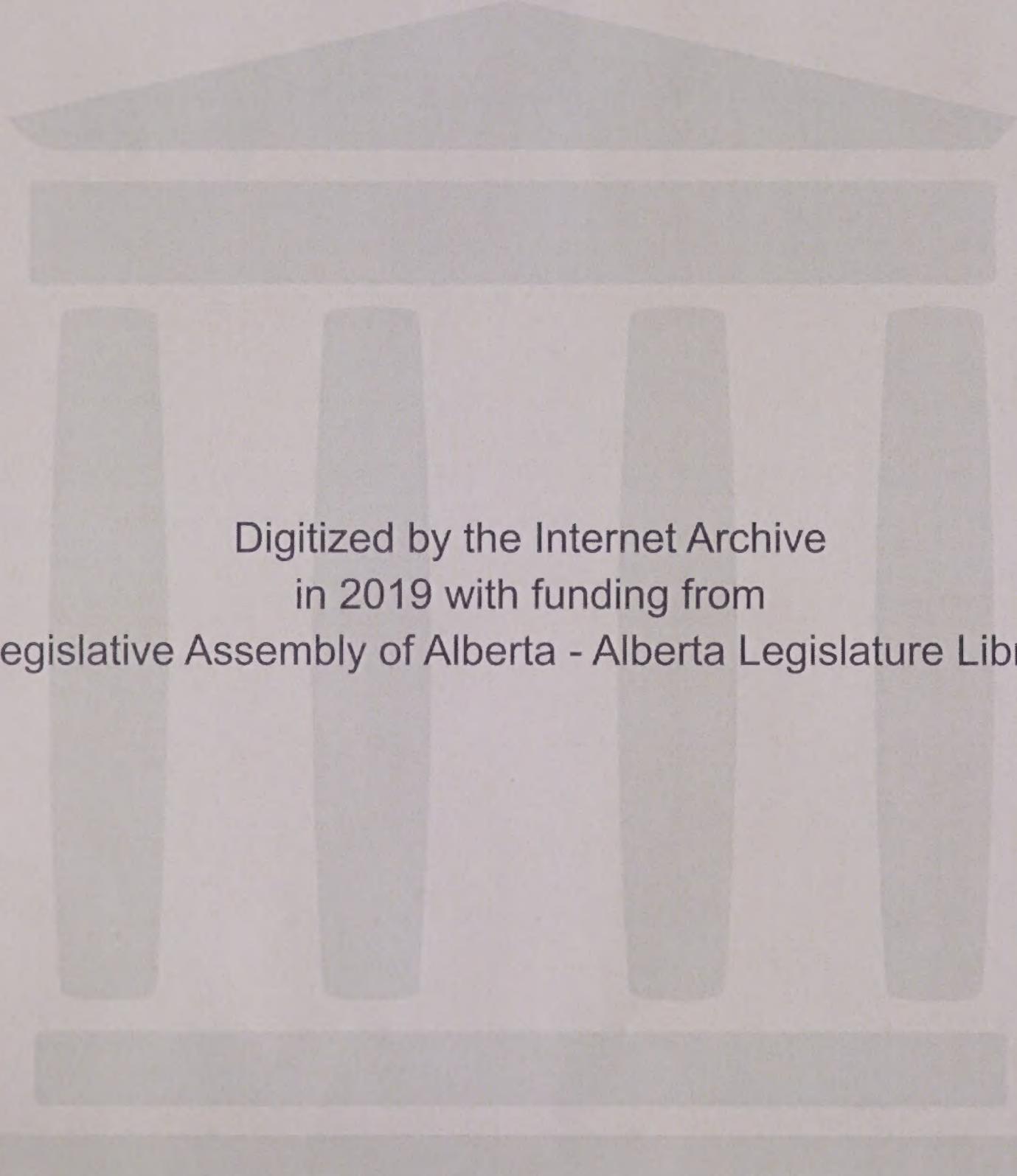
I. N. McKinnon Esq., Chairman

D. P. Goodall Esq.

Dr. G. W. Govier

**Session:** SEPTEMBER 18th, 1951.

Volume 6

A faint, large watermark of the Alberta Legislature building is centered in the background. The building is a classical structure with a prominent portico of Corinthian columns supporting a triangular pediment. The columns are fluted, and the building is light-colored.

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### VOLUME 6.

18 September 1951.

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VOLUME 6.

September 18th, 1951.

CHARLES R. HETHERINGTON,

recalled, already sworn, cross-examined by Mr. Fenerty, testified as follows:-

Q Dr. Hetherington, dealing with this plan for limited export from Pincher Creek as submitted by you in evidence on September 12th, I want to ask you a few questions. Perhaps first I want to ask you if there has been any discussion with or concurrence by the Gulf or Canadian Gulf Company in this particular plan?

A There has been none.

Q Referring now to Table 2, column 2, of the report presented in evidence, being the Table of Annual Billion MCF, which is carried forward in column 17 of Table 1, will you tell me if those Tables are intended to indicate the maximum desirable deliverability from Pincher Creek on the number of wells shown on column 5 of Table 2, and carried forward into column 20 of Table 1, or are the Tables merely to be rather supporting data to indicate that the specific number of wells can at least meet the demand upon them called for by the limited market which this particular plan proposes?

A Well, up to 1962 the number of wells is governed by the limited market, up until 19 wells are completed. Beyond that period, that is, the year 1962, the 19 wells are calculated to give quantity of annual gas at maximum capacity that can be calculated on the basis of the information that I have available.

Q You say as from 1962 these figures in column 2 of Table 2 represent, in your opinion, the maximum desirable delivery

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from these 19 wells, or merely indicate that you can deliver that much?

A No, that represents the maximum amount based on this production plan that I propose in this report, and also based upon the data available as to the productivity of the average well in Pincher Creek.

Q Or is it possible, and I do not want to get into too much technicalities at this time, is it based on the assumption or on the statement that if the 25% open flow is reasonable in the first instance, that this may be the maximum productivity of 19 wells?

A That is substantially correct, that if this sand face pressure drop, existing when 25% of the open flow used initially is reasonable, then this is the maximum. You are substantially correct.

Q And in your evidence I believe that you indicated that you considered that obsolete, the 25% open flow, is that right?

A Yes, and this Table contemplates deviating from that 25%.

Q What I am getting at is this, that this evidence can be interpreted as the maximum desirable delivery after 1962 and it is based upon certain assumptions with which you do not necessarily agree as to the deliverability?

A Well, not necessarily. I have presented a plan here which deviates from this 25% of the open flow, and to that extent I am in agreement with the plan I propose.

Q Yes?

A I think the limitation that places these quantities as the maximum is the basic data that was available to start with.

Q What I am getting at is this: You do say you can go this far; you do not say that you cannot go further?



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A I say that on the basis of the available data you cannot go any further. If there were some better data, it could be expanded, but on the basis of the data that was available, and which is summarized on this page 15 in the next to the bottom paragraph, this Table 2 is as far as you can go in the production at Pincher Creek. Now, if there were better data that would show that the field can produce more gas, I would sure like to know it.

Q Well, coming back to the period up to 1962, the rate of development there, I think you admit, is one which is, or may I ask if it is not, in your opinion, one that is designed to be geared to this limited market, limited initial market?

A Yes, it is. I would say up to perhaps 1959 it would be geared to the limited market. Now, just how many wells Gulf can drill in any one year I do not really know. I would imagine that they probably would not put in more than three rigs in there at a time.

Q Yes?

A Annually, and this has the addition of one well a year up here in 1953, 1954 and 1955, as a limitation to the limited export market rather than a limitation on the number of wells that can be drilled.

Q So that if this field were geared to a larger market, it would undoubtedly be sound practice, if within the abilities of the owners, to develop it much more rapidly than called for by this plan?

A Well, somewhat more rapidly. I do not think it would be a whole lot more rapidly. You could probably drill three wells a year there.



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Q Well, just to put it in a nutshell, this way, that the limited market proposed by this plan and the consequent plan for the drilling of wells delays the development beyond what might reasonably be the development if a larger market were available for this field?

A Well, for the first six years the development would be slower than if a large, a much larger market were available to us.

Q Now, as to maximum deliverability, the maximum desirable deliverability, as I read it, you produce only about 50% of the Pincher Creek reserves in 30 years under this plan?

A 63%.

Q What reserves are you working on?

A The Board's estimate of 1170.

Q The Board's estimate of 1170 as recoverable or in place?

A No, that is recoverable.

Q And you come to 63% over a period of 30 years?

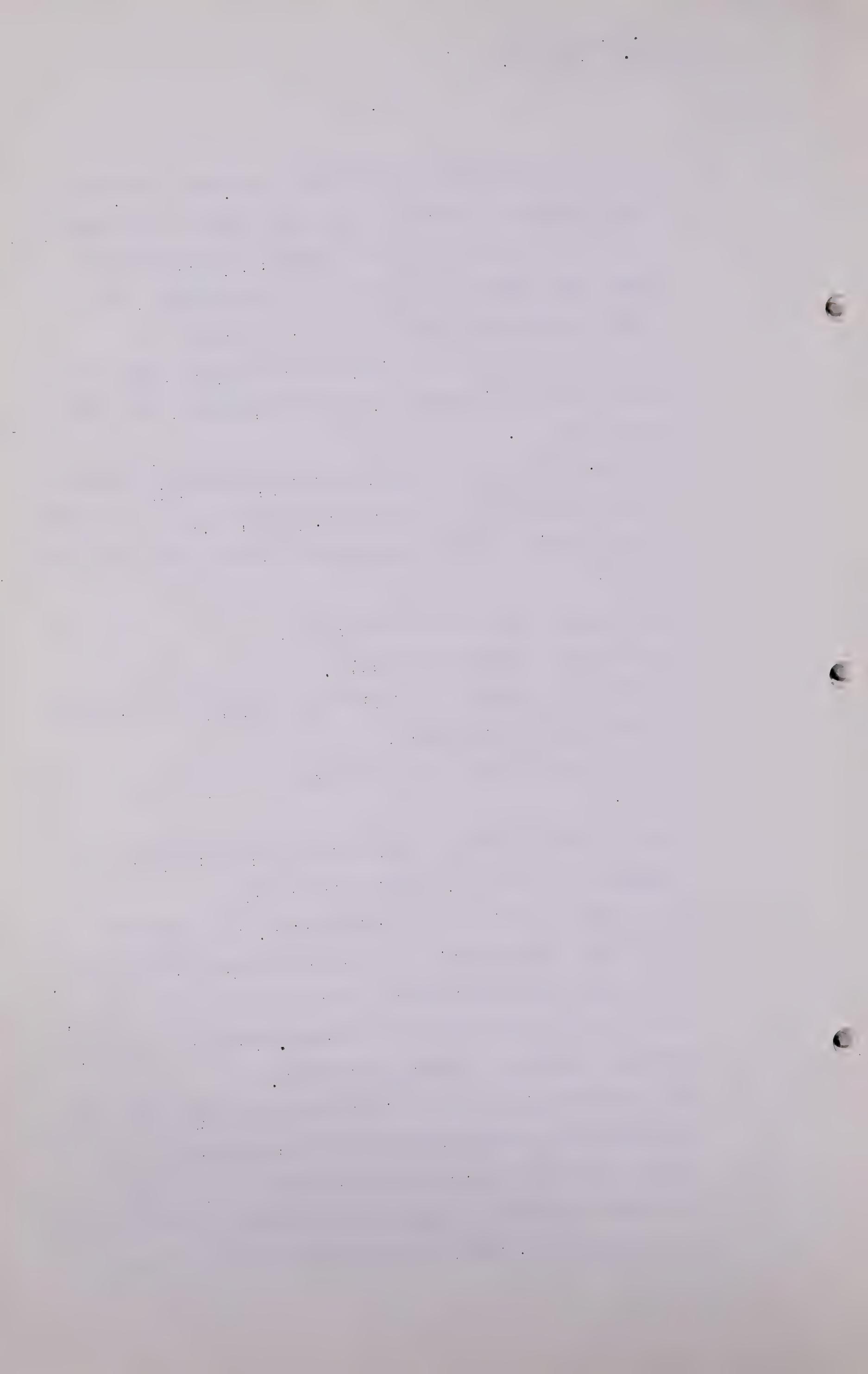
A Yes.

Q Well, do you think that that is not discrimination against the field by putting it at 63?

A It is not a matter of discrimination, it is a matter that there are certain laws about the production of gas, and if you stick strictly to this 25% of the open flow, and the data that Gulf has given Dr. Nauss is correct, then you would not produce this much.

Q You say 63% over 30 years is in accordance with the rate of production proposed throughout this Hearing?

A 63% is production greater than the rate of production otherwise proposed at this Hearing if 25% of the open flow were adhered to, and if the 25% of the open flow were



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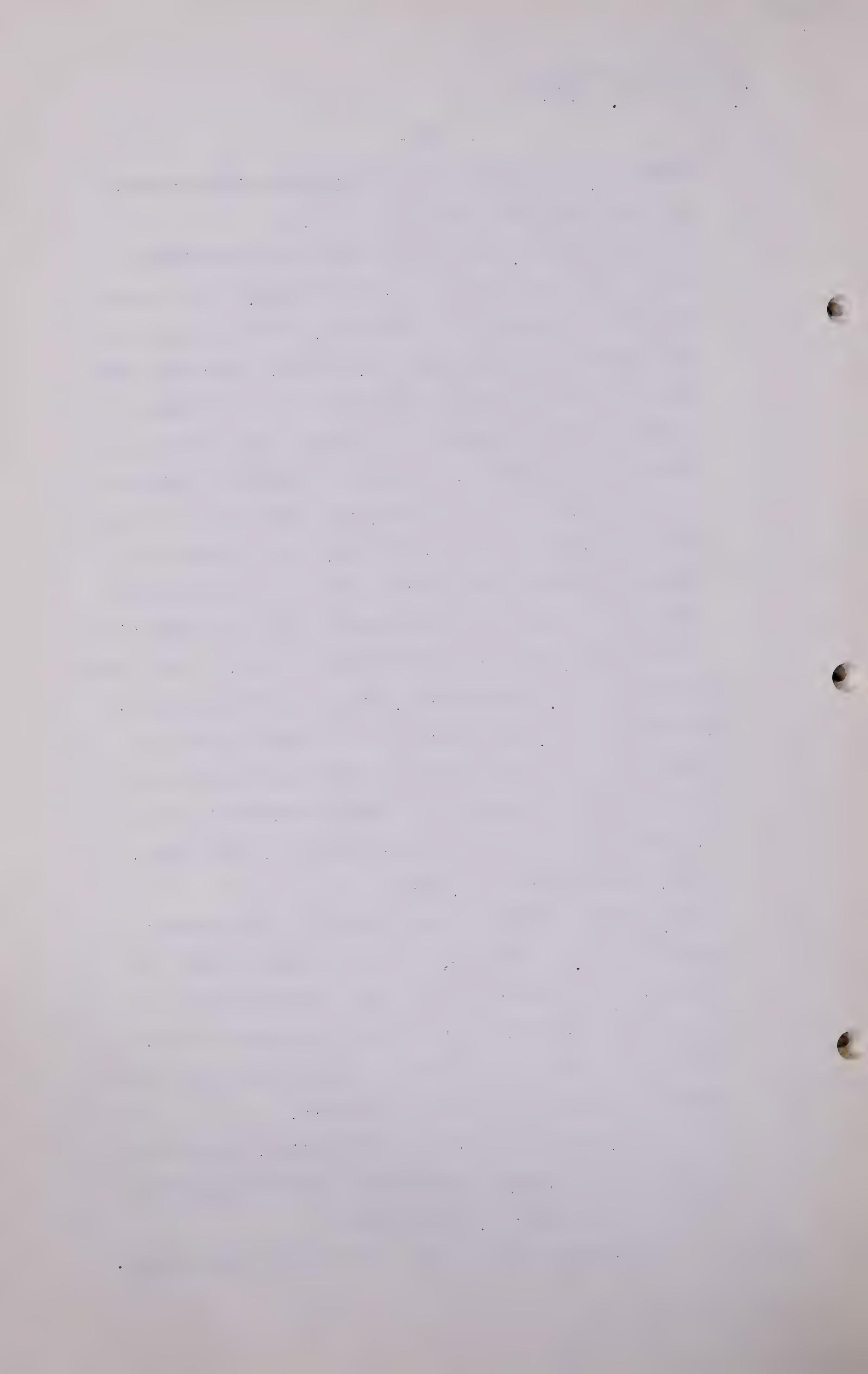
adhered to, then you could not calculate with a pencil that this much gas would be produced.

Q Just to test that, and I do not know how far afield I may go, but I am going to go ahead anyway, as I understand the northern part of the plan, which is a part of this submission, you propose or, rather, Westcoast Transmission proposes an annual export of from, an annual delivery up to a maximum of 70 billion cubic feet by the northern route from such reserves as might be available to be dedicated to that export, if permitted? I believe that that figure is correct. Now, this present plan proposed involves a production of from 25 to 35 billion cubic feet annual production maximum from the field with reserves in excess of 1 trillion cubic feet. That brings me to this, Dr. Hetherington, will you kindly tell me, in testing this, whether it is in any way a practical plan? What are your figures on the reserves proposed to be dedicated or allocated to northern export in accordance with the entire plan of Western Pipeline, I am sorry, Westcoast Transmission Company?

A Well, that is not the subject on which I gave direct evidence here. However, I want to clear up just one thing in your question there. You said an export of about 25 million or billion cubic feet a year. Now, in addition to that it is proposed to give almost that same quantity of gas to the City of Calgary.

Q No, I said production of 25 to 35 billion, I did not say export, and I think you might take it that those are the figures on production. Am I wrong?

A Well, I misunderstood you then, if you said production.



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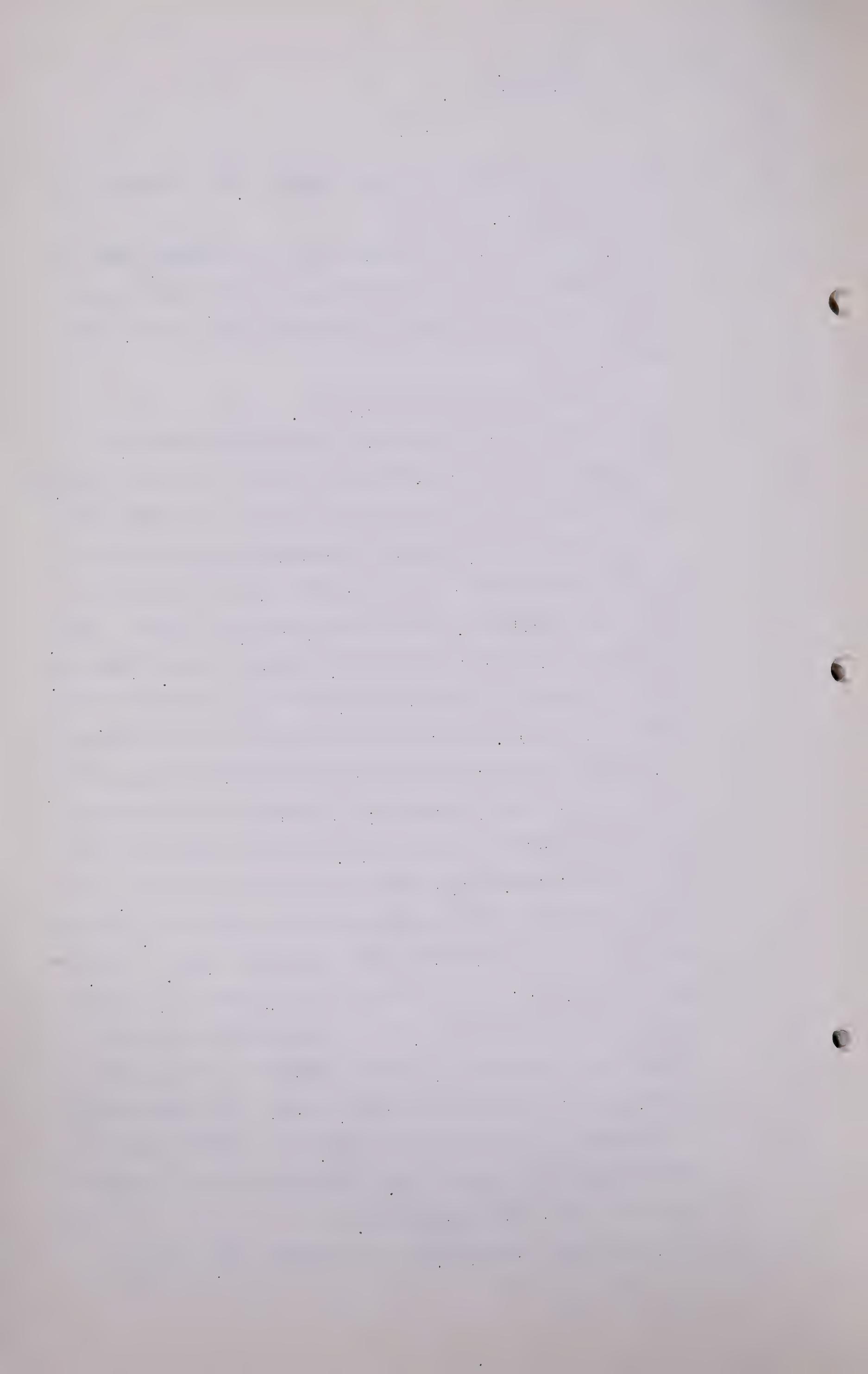
Q Yes, I think I used the word "export", but I caught myself on that?

A Well, the matter of reasonableness as to whether the proportion of delivered gas related to the reserves is consistent with this plan or another plan is beside the point.

Q Well, I just happen to be curious.

A My limitation of Pincher Creek to these volumes that you point out here in column 2 of Table 2 is based entirely on a calculation method described here to the Board, and is not based on any desire to restrict Pincher Creek or produce any more gas out of Pincher Creek than can be actually calculated, using this engineering method. Now, the method is a basis of certain physical data, that is, having regard to tests on the Walter Marr and the Pincher Creek No. 1 well, provided by the Canadian Gulf Company to Dr. Nauss and submitted as evidence in this Hearing. Now, based on that data, using this calculation method which has been described to the Board, and with which they are already familiar, using that method plus these data, this is the quantity of gas calculated to be delivered, calculated that can be delivered out of Pincher Creek. Now, if more gas, or if the data had been brought up to date and more tests had been run to show that the wells are larger than indicated in Gulf's submission through Dr. Nauss, then it would be possible, using this same method, to calculate a greater flow of gas, but based on the data presented by Gulf to Dr. Nauss this is the largest quantity that can be calculated.

Q Well, we could eventually, if we get that far, come to



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the question of how the maximum deliverability from northern reserves could be calculated, but for the reason indicated I still come back to the question then, this being really a portion of a plan, that is, the southern part, what is the calculation of Westcoast Transmission as to the reserves which might be dedicated to the northern export?

A Well, I think Dr. Nauss's estimate is given in his Exhibit 4 as 1027 billion cubic feet in the Peace River area.

Q Well, roughly... well, that is less than the Gulf reserve?

A Yes.

Q But, as I say, the plan proposes a maximum annual delivery in the northern area of 70 billion, and it is certainly much less than the southern, and I think what you suggest is that there is a southern excess of perhaps  $2\frac{1}{2}$  trillion in your evidence, accepting Dr. Nauss's statement at page 184. That statement is in your evidence quoting Dr. Nauss,

"His present estimate for the same fields, plus new discoveries not then considered, is 2517 billion cubic feet."

A I believe that is correct, yes.

Q That is southern uncommitted reserves?

A Yes, I think that is right.

Q Including the Table as shown, or the total, I mean, as shown in the Board's Interim Report, plus subsequent discoveries?

A I believe that number is correct.

Q And it is from that reserve that you propose, at least, in this scheme, that we see a market only for 25 to 35



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billion cubic feet annually. Now, I must go on to some other aspects of the practicability of this plan. I assume that the plan is put forward, this one, not as a mere theoretical disposition of gas, but as a practical plan to utilize it?

A You are entirely correct.

Q Then what price for the gas does this plan calculate, what is the price for the gas in this southern portion of the plan which the economics of this supposedly practical plan calculate?

A That is a matter of negotiation with the companies involved. It is not in my sphere as a technical witness on the amount of gas that can be physically produced.

Q That did not enter into your calculations with regard to this plan?

A It entered in only to this extent, that the pipe lines proposed are short pipe lines, short pipe lines to a high-priced market where industrial fuel is on the order of 50 cents an Mcf in value.

Q Do you say that the Montana market is a high-priced market?

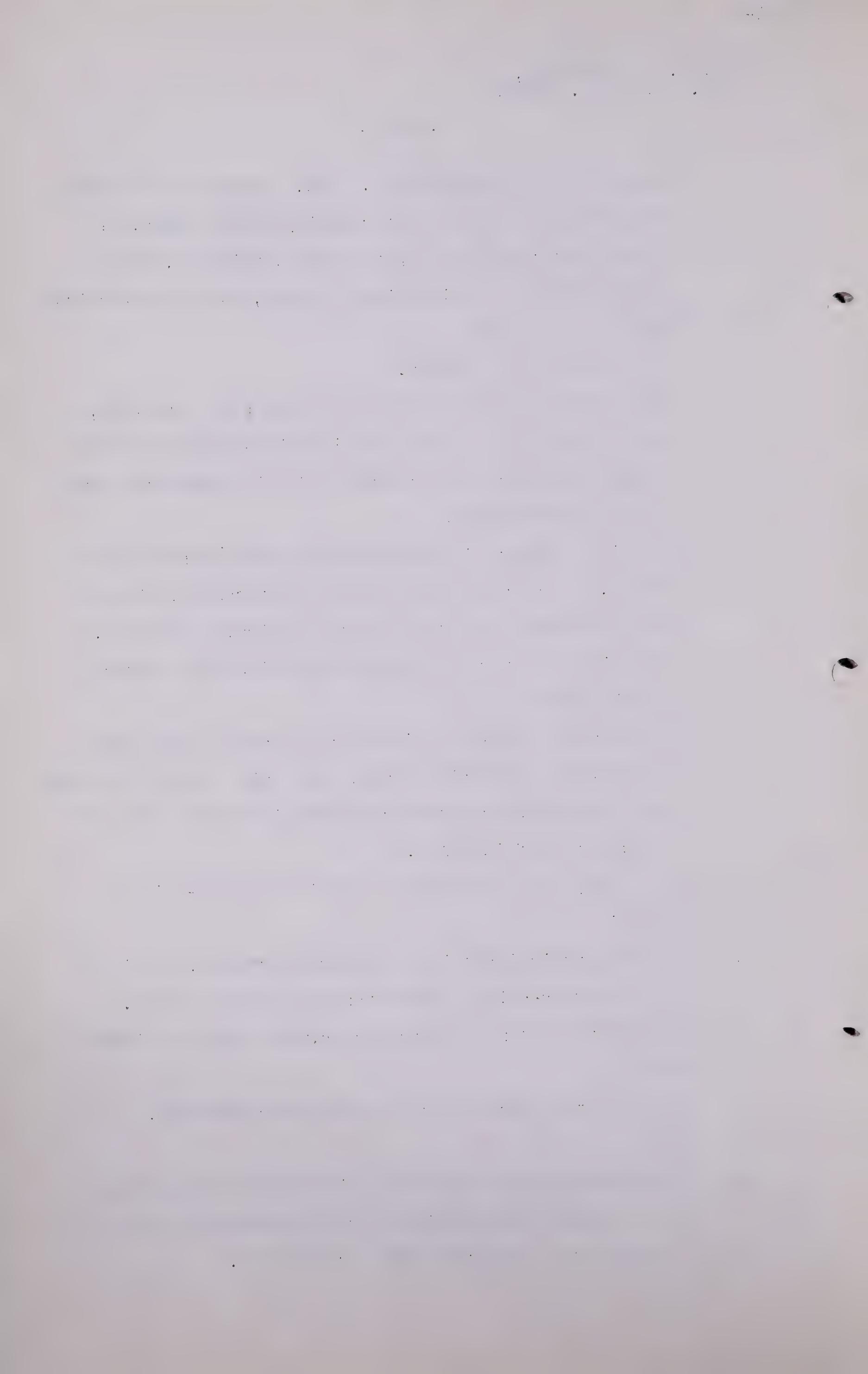
A Spokane particularly is a high-priced market, and it is a much higher-priced market than the Pacific Coast.

Q But Spokane has a low load factor, with regard to industrial?

A It has a good market for domestic and commercial.

Q Yes.

A The combination of short pipe lines and a high-priced market should make possible for the companies to get together on a very good price for this gas.



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Q Have you included in your calculation of this practical plan any price?

A No, I have not. I think I have stated that once before.

(Go to page 432)



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Q It would be entirely a question of price as to whether it would be at all practical from the point of view at least of the producer?

A I would imagine so, yes.

Q You are not prepared to say that you have weighed the scheme in the light of that price except as to what you might be able to get?

A Only as to the general statement that I made that the pipe line is the shortest and to the highest priced market.

Q I believe that this plan purports to be framed within the suggestions of the Board in the Interim Report, at least to meet certain suggestions and certain findings of the Board?

A Yes.

Q In the Interim Report. I believe that report with which you are familiar recognizes it pretty well is a matter of last resort that the Pincher Creek reserves might be employed to rectify the Canadian Western Natural Gas reserves' deficiencies?

A It was the use by Canadian Western alone would be the last resort.

Q Still I do not know what happened yesterday. I have the impression that it was a question of when the use of this scheme might make it available to Canadian Western. I believe you were questioned about the case of Canadian Western and using the gas in this market?

A That is correct, counsel being careful to reveal the small volumes of that particular gas and not to give too much



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attention to the larger volumes and when that gas got lower then it would make up this last resort so-called.

Q I would like to get some figures from you, if you can give them, as to the Pacific Coast market proposed to be served, the demand in the Pacific Coast market proposed to be served by the proposed northern export. I am wondering if, among other things, whether you propose to use the reserves alone in this northern area to supply that market or as to whether you propose to use Pincher Creek reserves in any measure to supply the Canadian Western Natural Gas deficiency?

A No, the proposal is to serve the Western market strictly from the Peace River area.

Q Can you give us your latest figures?

A We presented those at the last hearing?

Q That was a year ago?

A That is right. It calculated out at about 30 billion in the first year and went up to 70 billion in the fifth year.

Q Have you your new figures?

A No, they are the same figures.

Q What would that mean as a per day average over the first five years?

A It would average 190 to 200 millions a day the first five years, peak load.

Q Which I believe totals for your proposed commitments of reserves slightly more than 1 trillion cubic feet?

A That would be for initial capacity.

Q That is all you can see at the moment on your submission,



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is it not on the present evidence before the Board?

A Those are the reserves by Dr. Nauss, yes.

Q Is a trillion cubic feet an adequate reserve for a market of 190 million cubic feet a day?

A With an area with such possibilities for development there is enough gas there to support the initial capacity. It has historically been done in the United States where certificates have been granted on an initial capacity of such a reserve and came back to the jurisdictional authorities for increased capacity when the reserves were increased later. There is enough gas in the Peace River for the initial capacity of this project.

Q What you are saying is that you consider these 1 trillion cubic feet initially adequate and hope additional discoveries of additional reserves may build up to an adequate figure?

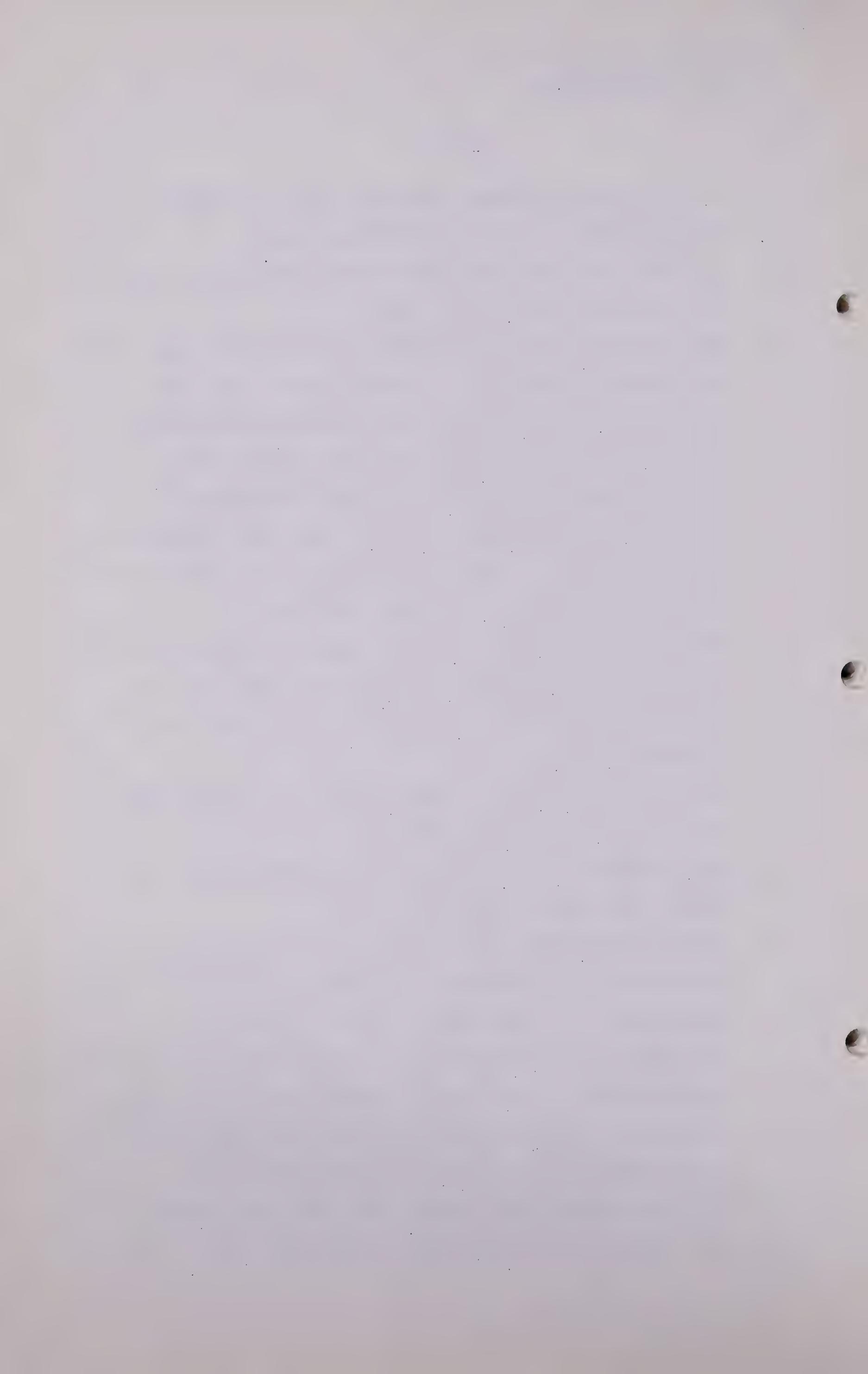
A No, I say the reserve is adequate for the initial capacity of this project as requested.

Q Is it adequate to support an average market demand and supply 190 million cubic feet daily?

A I say that depends upon the attitude that the authorities want to take with respect to the number of years of reserves. As I pointed out yesterday in direct examination to Mr. McDonald the Federal Power Commission has given some authorizations on deliverable reserves as low as 8 years in which the gas was taken through an area where there was a good opportunity of picking up additional gas.

Q And this decision you mention, when was that decision?

A The decision I am speaking of, I had a part in it, the .



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Michigan and Wisconsin Pipe Line Company docket: G-1156.

Q What year?

A That was 1949. I believe Mr. Davis made the reserve estimate.

Q MR. STEER: What is the Company?

A The Michigan and Western Pipe Line Company. They had sufficient reserves of natural gas to support an initial capacity of 75 billion cubic feet and they denied the request for a full capacity of 110 billion cubic feet. They granted a certificate for the initial capacity and later on when the reserves, further reserves, were found they granted a request for full capacity of 110 billion.

Q MR. FENERTY: I am not going into the special features of that. There might be personal triumph or success but let us assume you come into a market with a planned reserve committed of 1 trillion cubic feet and let us assume that you cannot buy any more gas, is your reserve of 1 trillion cubic feet adequate to provide for this particular market, that is the Pacific Coast market for the life of the proposed market, which is say 25 years with an average daily capacity of 190 million cubic feet?

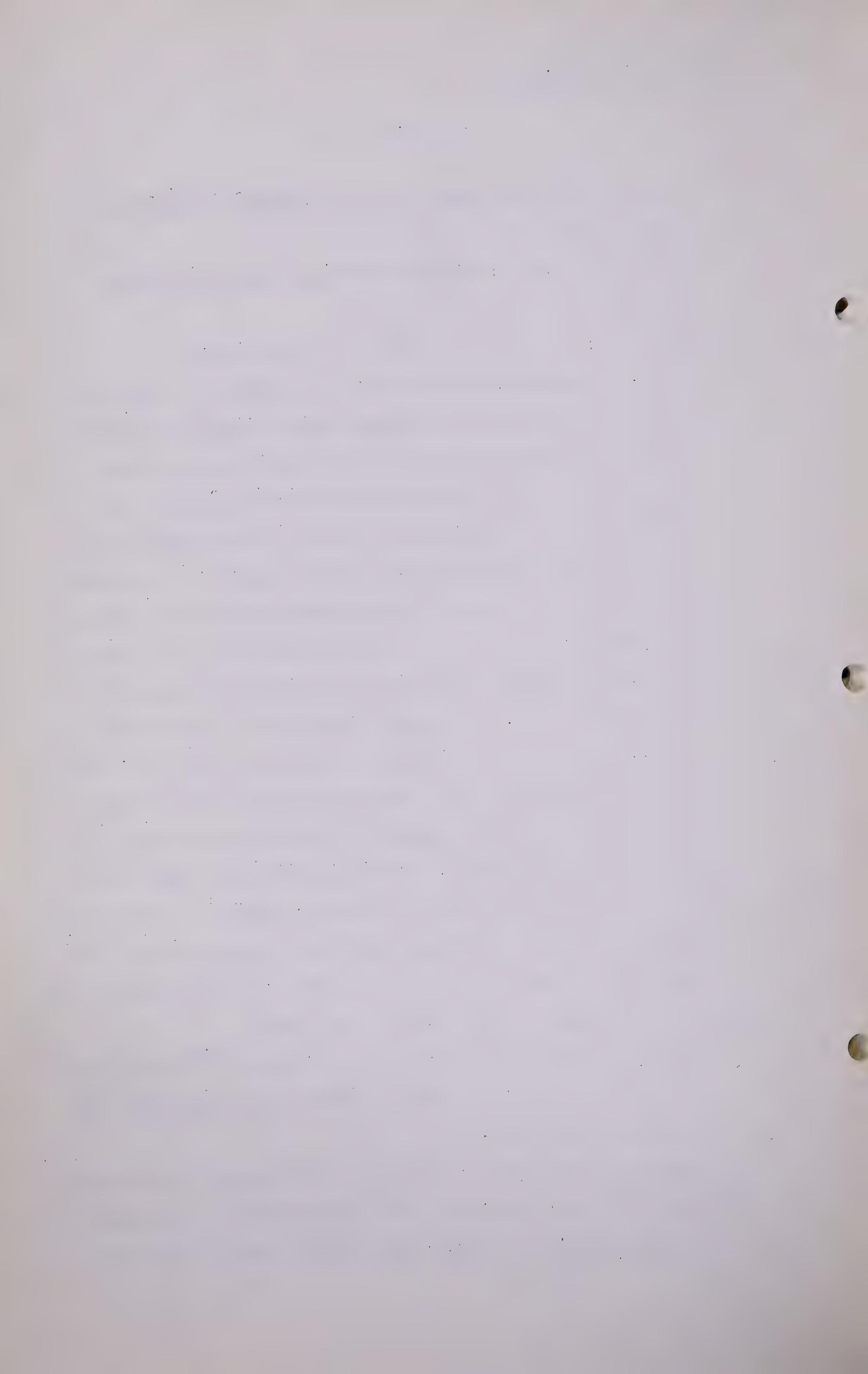
A That is not the average. I gave you the average peak load.

Q I did not ask you the average peak load?

A Well, I would make a correction. I used a 75% load factor in that calculation. Calculating it now I would say 140 million cubic feet.

Q The question may be repeated with an amount of 140 million?

A That is about 50 billion cubic feet and say an average of 20 years' gas reserve. The Federal Power Commission



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a few years ago, on the request of the Texas Eastern Transmission Company, had granted a certificate when I believe it had 94% of the gas in the ground for 20 years with a deliverability for 8 years. In that case, the Commission decided it was an adequate reserve because of the type of territory through which the line passed, which was susceptible to added gas. I believe in this case, in answer to that question, the reserves present in the Peace River area of 1 trillion cubic feet to serve a capacity of 140 million cubic feet a day average for 20 years is adequate.

Q It is not still qualified by this, if you can count on additional reserves?

A I think that is right.

Q And the maximum daily average requirement in this market, I believe, was suggested at 70 billion. Is the calculation for that here of 190 million a day approximately correct?

A Yes.

Q Now I think we have come down to this, that actually on this proposed market, even looking at the average for the first five years, that the reserves which are put forward as being available, presently available to be committed to this market, being the reserves in the northern part of the Province committed to the Pacific Coast market are not adequate reserves in themselves for that market, for that line?

A I think that is just as clear in Dr. Nauss' evidence when he said that these wells were drilled for oil and they just block out oil like they block out coal and



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certainly you will have to come back and do some further drilling to expand those reserves for Westcoast.

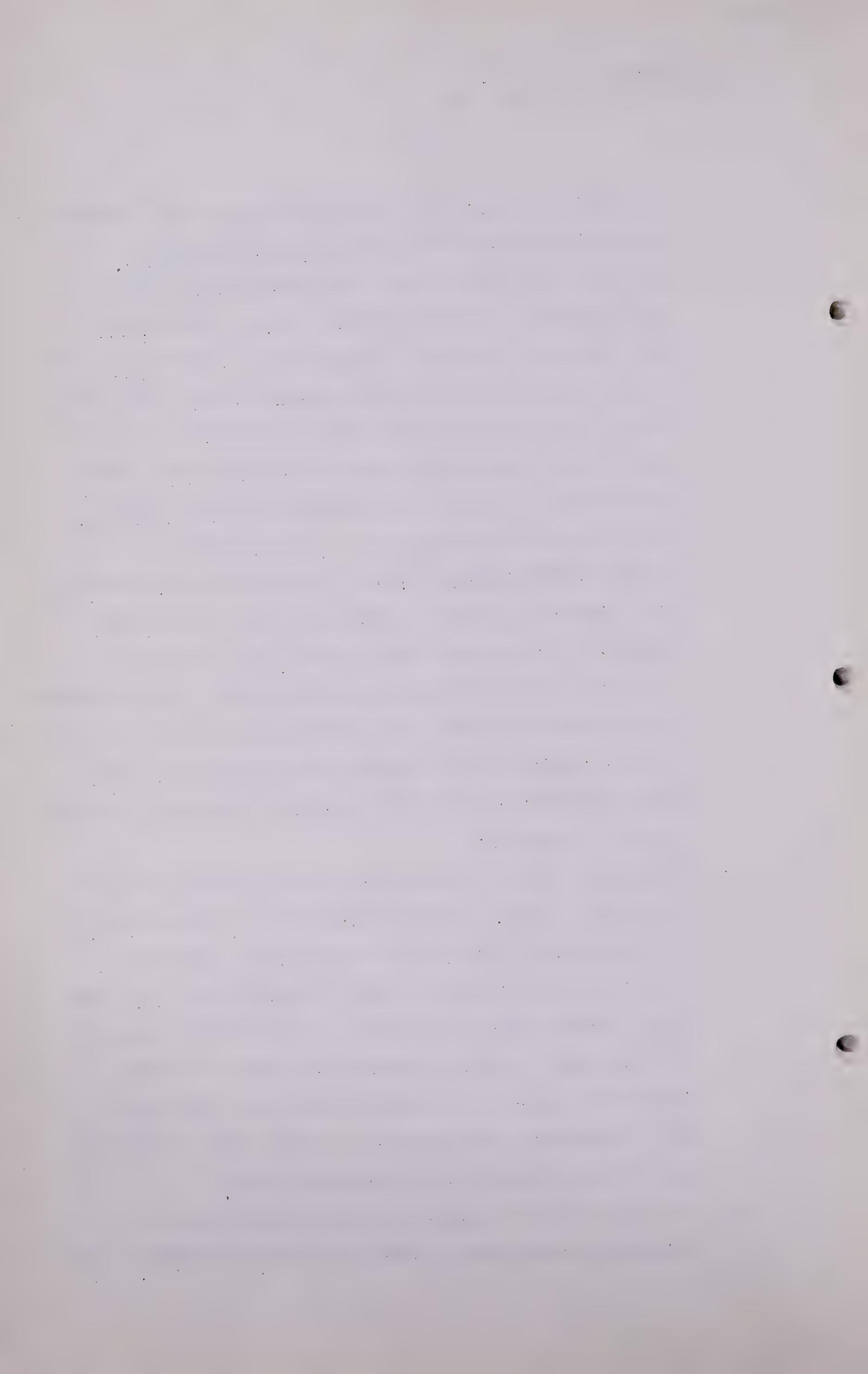
Q Have you taken into account the financial situation of the scheme as a practical scheme and the possibility there may have to be more exploration in the northern area to increase those reserves, during which time under this scheme the southern reserves may be committed to the Alberta market and during which time the Pacific Coast market might be supplied by another source of supply?

A Would you repeat that question, if you please?

BY THE REPORTER READING: "Q. Have you taken into account the financial situation of the scheme as a practical scheme and the possibility there may have to be more exploration in the northern area to increase those reserves, during which time under this scheme the southern reserves may be committed to the Alberta market and during which time the Pacific Coast market might be supplied by another source of supply?"

A That whole matter has been given very serious consideration and I feel, and my associates feel, there is ample gas in the Peace River area to permit the granting of export at this time and it will certainly stir drilling to the extent that reserves will be more than adequate in that area. In the meantime this supply has been limited to export, not because that is all the market that is available but primarily because that is all the gas we can calculate on as being available.

Q Assuming export is permitted and assuming all the necessary permits of the various types are granted, how



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soon thereafter does the company propose to start to supply the Pacific Coast market?

A As soon as this permit is granted it is proposed that the Ottawa authority will be obtained, a Federal Power Commission certificate certainly will be obtained and if the certificates were granted this year the pipe line would be under construction next Spring.

Q And you think you have sufficient reserves in the northern area?

A It is adequate for this initial capacity. We have to build a pipe line and we shall have to increase our reserves.

Q On the assumption you can get further reserves?

A That is certainly the assumption, yes.

Q Could this northern line be economically built for the deliveries you have mentioned, say 140 million average for the first five years?

A You say can it be economically built?

Q Yes, in your opinion?

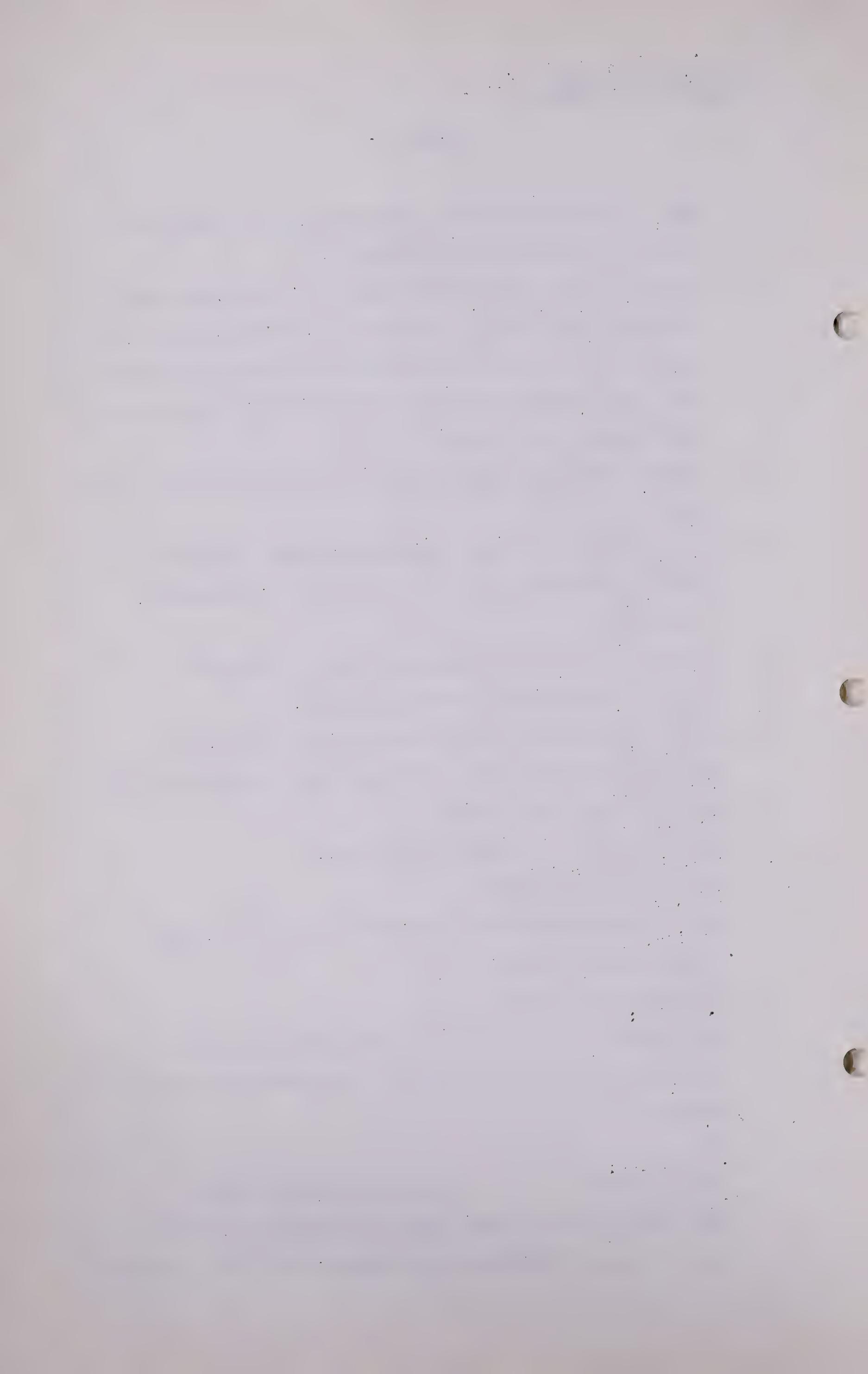
A Well, we presented this cross-data at the last Joint Hearing, as I recall.

Q I think that is all.

Q MR. STEER: You are talking about the high price market and I hope you are talking of the export market?

A Yes.

MR. McDONALD: The other day you asked Dr. Hetherington to deal with the matter of Redwater gas and he has put together some figures which I am submitting



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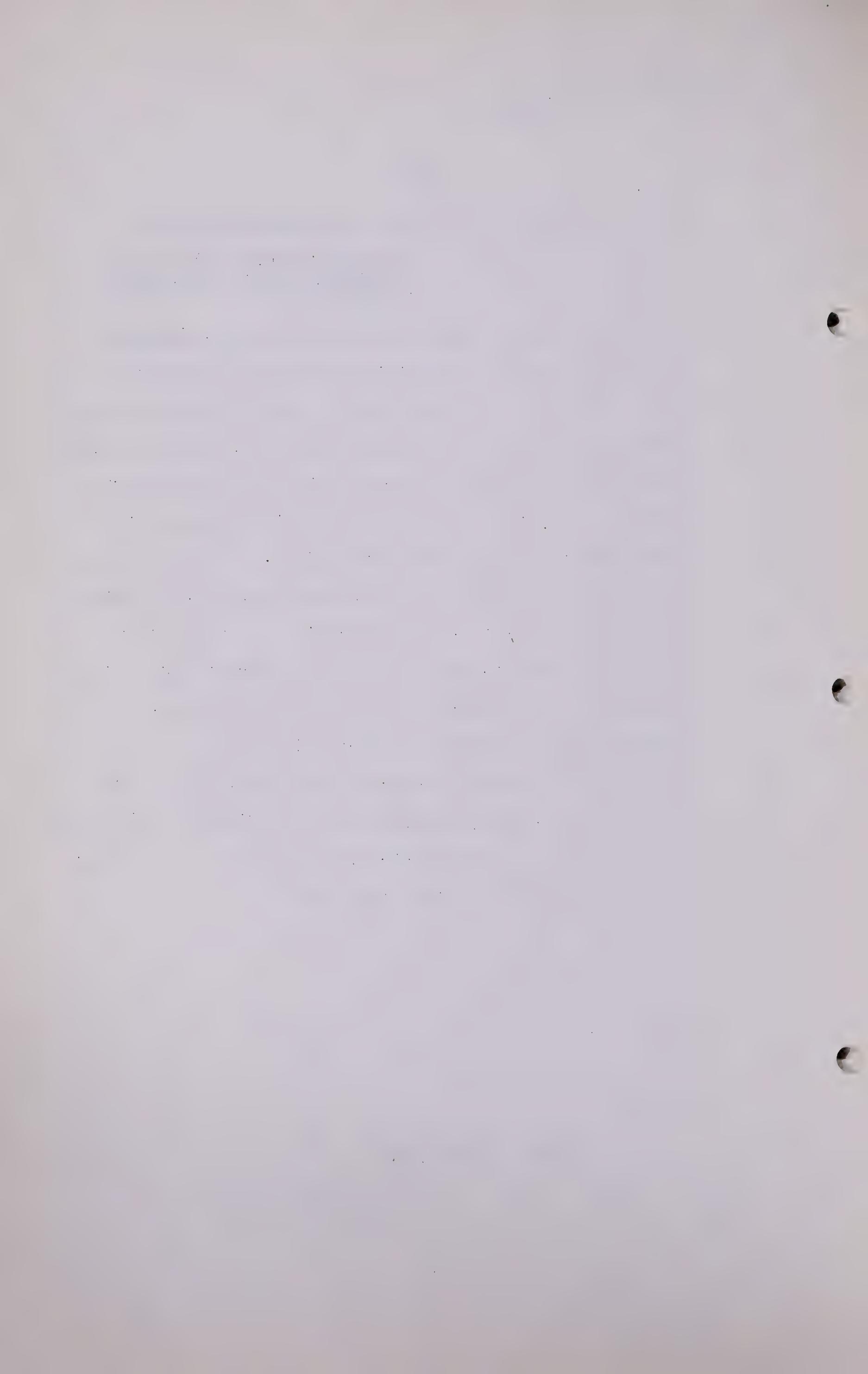
now and he can give a word of explanation for it.

DOCUMENT "PRELIMINARY STUDY  
OF REDWATER GAS" NOW MARKED  
EXHIBIT 11.

Q Dr. Hetherington, will you deal with your submission here with regard to a preliminary study of Redwater separator gas? You might explain how you arrive at that.

A This exhibit gives the results from a preliminary study, just to take a look at the collection of the Redwater separator gas, in answer to the Board's request for additional information on that subject. The basis for these figures is given as oil production, 100,000 barrels per day; the gas/oil ratio 180 cubic feet per barrel down to atmospheric pressure, and a separator pressure of 35 pounds. In respect to the separator pressure, a pressure of 35 pounds was selected in order to permit the gathering of this gas through a reasonably sized pipe line without compression inside of the field and also for operation at the atmospheric pressure to keep the possibility of air getting into that gas.

(Go to page 440.)



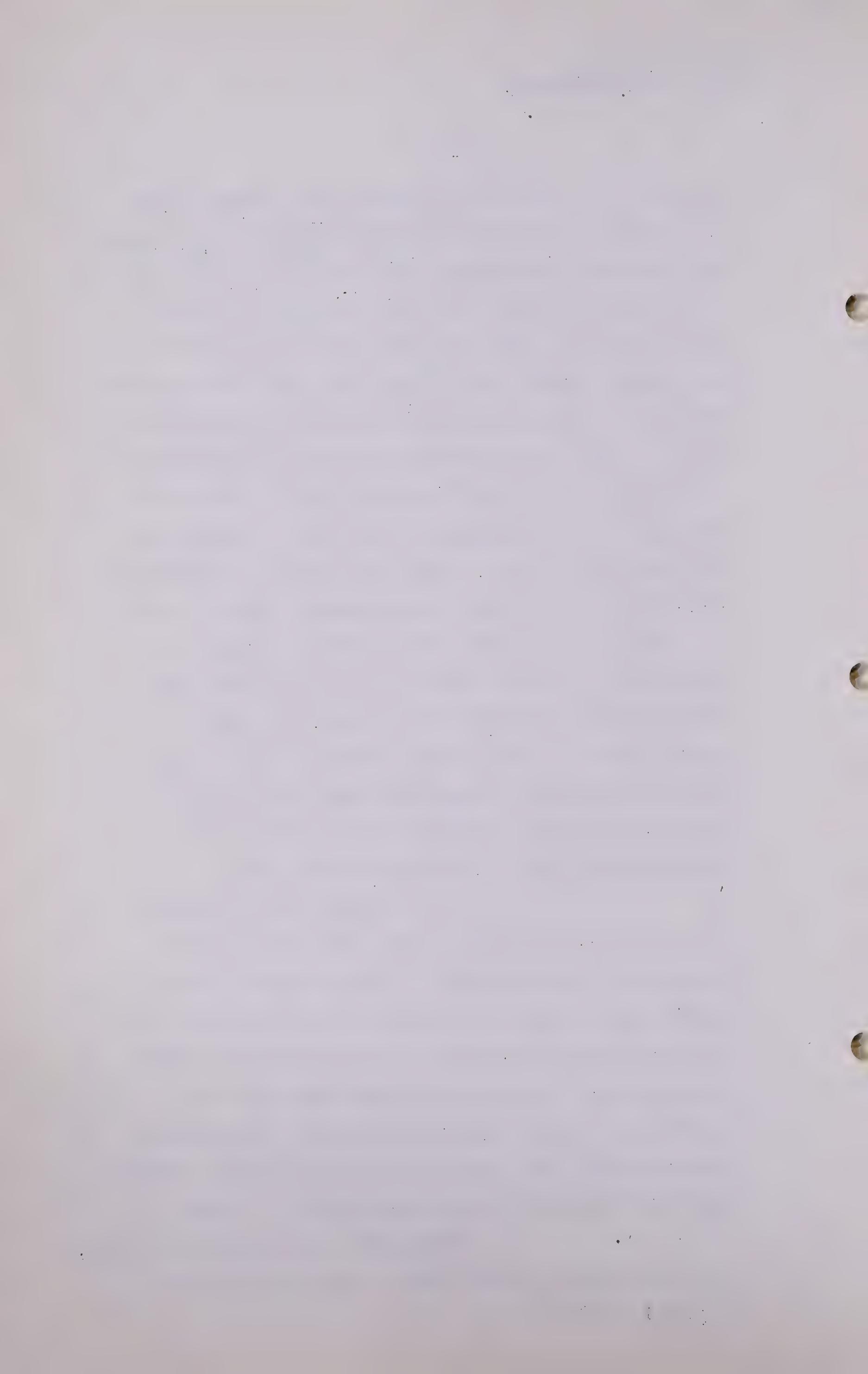
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A Actually the separators at Redwater run between 10 and 75 pounds. Certain of the recently completed wells have been equipped with emulsion treaters, rather large tanks 8 to 10 feet in diameter. They are only good for 12 pounds pressure. Those emulsion treaters generally serve also as gas separators. In the cases where those emulsion treaters are already installed it will be necessary to instal a separator up-stream of the emulsion treater in order to work this operation at 35 pounds. Most of the wells are already equipped so that they can operate at 35 pounds gas pressure. The total raw gas is 18 million cubic feet per day. That is intended to mean the total gas off those 180 pounds of oil per day and includes not only the separator gas but all of the stock tank vapors and any other field use of gas. The average dry gas is taken at 9 million cubic feet per day in accordance with the Board's suggestion that there would be a 50 per cent shrinkage between raw gas and dry gas. Annual gas quantity of 3.3 billion cubic feet.

As to estimating the recovery of gasoline from gasoline plant, the exact number of barrels to be recovered on the type of plant, I have assumed here it would be strictly a 26 pound natural gas plant with no recovery of butanes and propanes. Based on 8/10ths of a gallon per thousand cubic feet an operation at about 10 million cubic feet a day average of wet gas into the plant would give this 70,000 barrels per year. Gasoline values taken at \$4.00 a barrel.

This next item, gathering system, just lists the pipe sizes and the inch miles of pipe



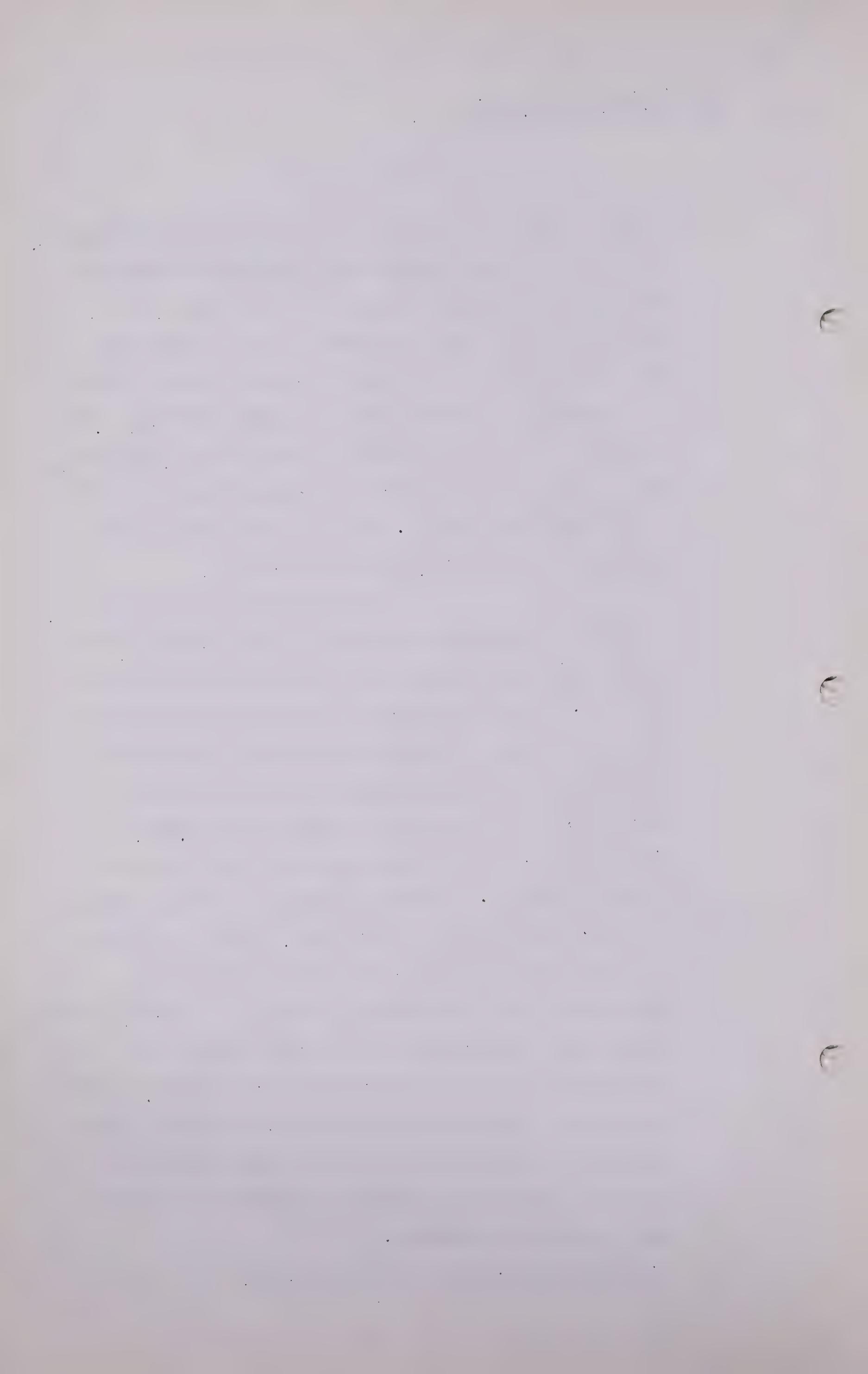
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roughly estimated to put a 3-leaf system into Redwater. It is a fairly easy system to gather gas from because the field is stretched out in one direction. A T-shaped line of 12-inch pipe could be set through the field with 4-inch connections to each section. The wells are generally manifolded into a central separator. The average is about 5 to 6 wells per separator, such that the gas has to be collected then only from about 1/5th of the number of wells. That also cuts down a little bit on the gathering system requirements.

The next item is capital cost, which is an approximate estimate of the cost of putting in the pipelines and plant to remove the sulphur from the gas, without converting or using it, just throwing the sulphur away. Gasoline recovery of this 17,000 and pipeline pressure suitable for approximation to Edmonton, that is estimated at about \$3,000,000.00 capital cost. The processing and delivery costs are summarized below. Gathering amounts to about 11 cents per Mcf., processing about 6 cents. There is a credit on the gasoline of  $8\frac{1}{2}$  cents and the delivery to Edmonton as taken from Exhibit 6 would be about  $4\frac{1}{2}$  cents, so that the total cost of collecting Redwater gas is in the order of 13 cents net after gasoline credit. As to whether this falls in the realm of economically available gas to Edmonton depends on whether Edmonton is in need of gas and whether the conservation of this gas is believed worthwhile.

Q Dr. Hetherington, just to make it clear, this is the



C. R. Hetherington,  
Dir. Ex. by Mr. McDonald..

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gathering cost to Edmonton?

A Gathering cost at the city gate at Edmonton.

Q Your 16-inch line, 32 miles, that is the line to -

A That is 32 inch miles. That is just a short stub of 16-inch pipe from the centre of Redwater running at right angles to the field.

Q Your 709 inch miles takes into account the line to Edmonton?

A No. The 709 inch miles is purely gathering. The line to Edmonton is in this last item, Processing and Delivery Costs, item 4, delivery to Edmonton. The capital cost of that delivery line is not included in this table.

THE CHAIRMAN: Does anyone wish to question Dr. Hetherington about this exhibit?

Q MR. STEER: Does this 13.1 cents represent simply the cost without profit to the operator?

A No, those cost figures at 7 $\frac{1}{2}$  per cent return to the operator.

Q MR. McDONALD: Over and above income tax?

A Over and above income tax and all operating and maintenance expenses.

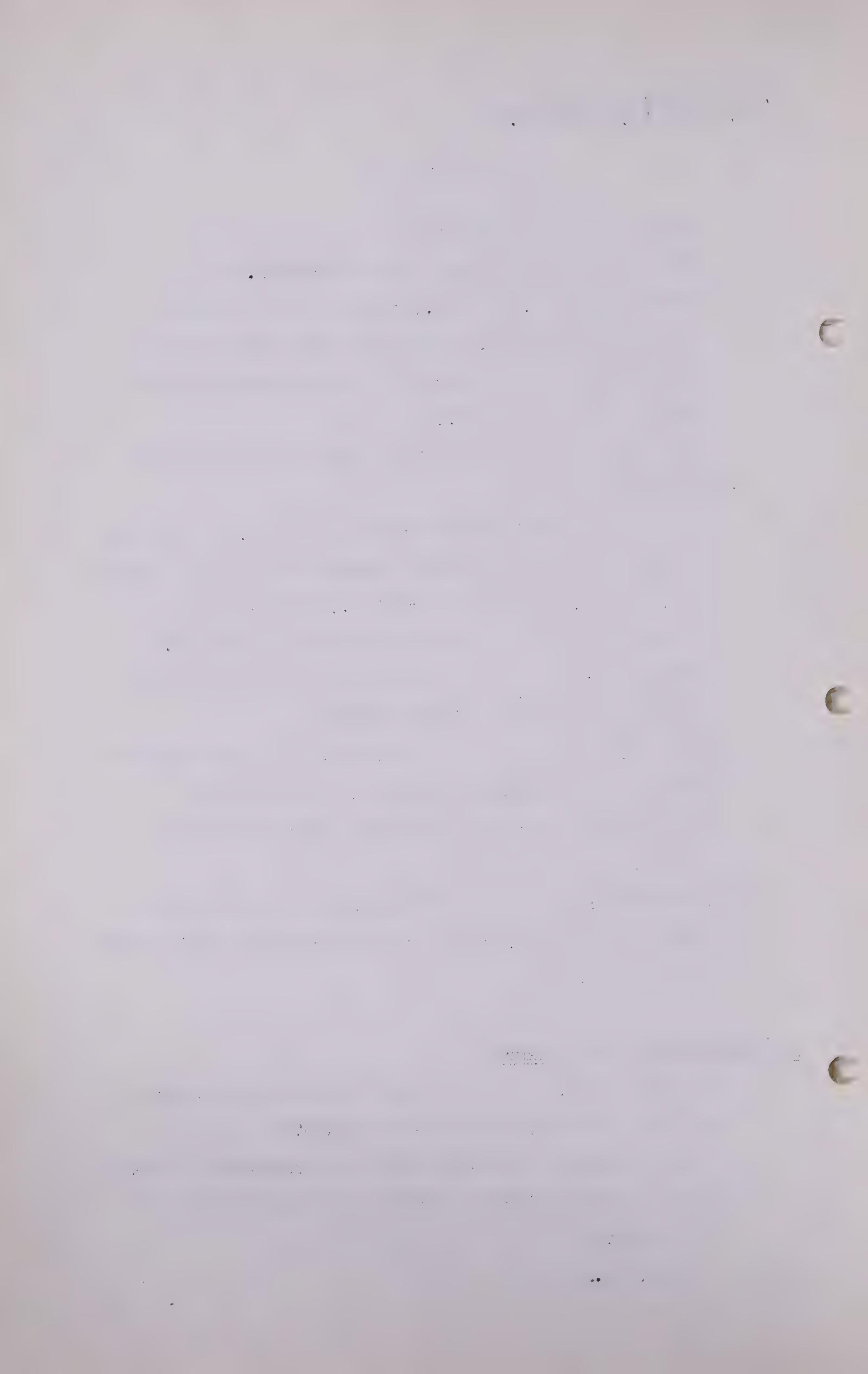
EXAMINATION BY DR. GOVIER:

Q Dr. Hetherington, do you think it likely that sulphur recovery could include this cost picture?

A I do not believe so because of the low sulphur content.

Q Did you make an estimate of the heating value of the finished gas?

A I did not, no.



C. R. Hetherington,  
Exam. by Dr. Govier.  
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Q Would you expect it to be higher than 1,000? I was thinking particularly of the fact that there was no C-3 or C-4 recovery?

A Well, yes, I would expect it to be greater than 1,000 Btu's.

Q I had one question, Dr. Hetherington, I wanted to ask you arising from Mr. Fenerty's questioning. You mentioned to him that your table 2 in Exhibit 5 was predicated on an initial rate of 25 per cent of open flow and it was my understanding that that was your recommendation. Is that correct, or did you start with 25 per cent open flow simply because at one stage that was the legal restriction?

A No, that is also my recommendation. I am in agreement with the use of 25 per cent of the open flow to start the field.

Q You do not know of any better way of starting out?

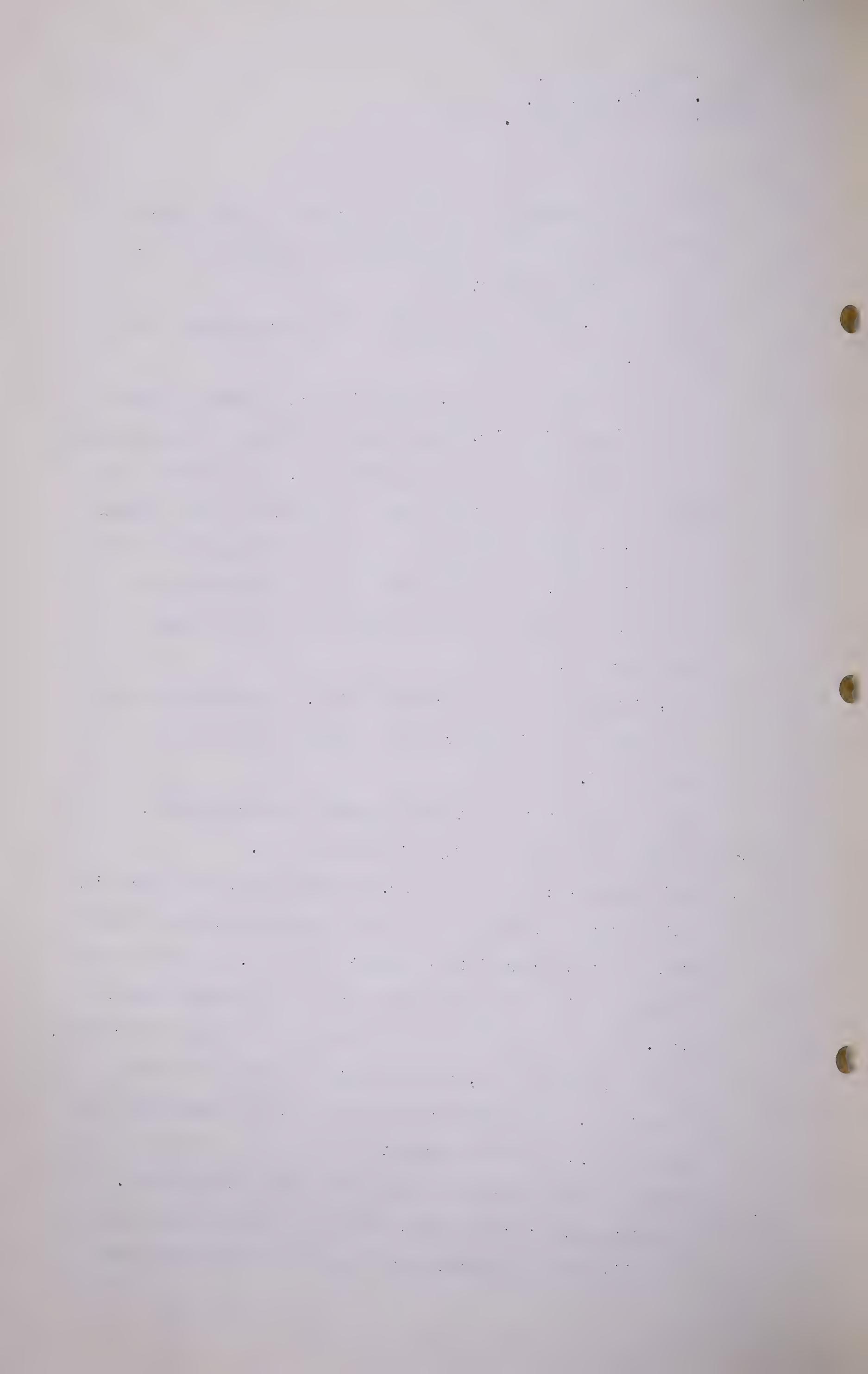
A I know of no better way of starting out.

Q THE CHAIRMAN: Dr. Hetherington, the operation of this plant, would that be at 100 per cent load factor that that calculation was made? That is, you would have about 10 million feet of wet gas per day steady load?

A Yes. This is based on 100 per cent load factor operation.

Q At the present time, and I pointed it out to you the other day, the Redwater production in the summertime is about double the wintertime?

A Perhaps I should expand that statement a little bit. It is my understanding that the 50 per cent reduction that the Board recommends between wet gas and raw gas



C. R. Hetherington,  
Exam. by The Chairman.  
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reflects this difference in summertime and wintertime production. If that is the case, then the volume of gas throughput through this plant would be less.

Q What basis of depreciation did you use in arriving at the costs of gathering and processing?

A That was  $3\frac{1}{2}$  per cent.

Q Beyond the figure of  $7\frac{1}{2}$  per cent return on investment?

A Yes.

Q Thanks, Dr. Hetherington.

JACK F. DOUGHERTY (recalled)

continued cross-examination by Mr. Steer:

Q Mr. Dougherty, I asked you a question yesterday and I cut you off before you finished your answer. It had to do with the pipeline construction on which you personally had advised on the reserves and you mentioned two of those. Would you complete that answer for me?

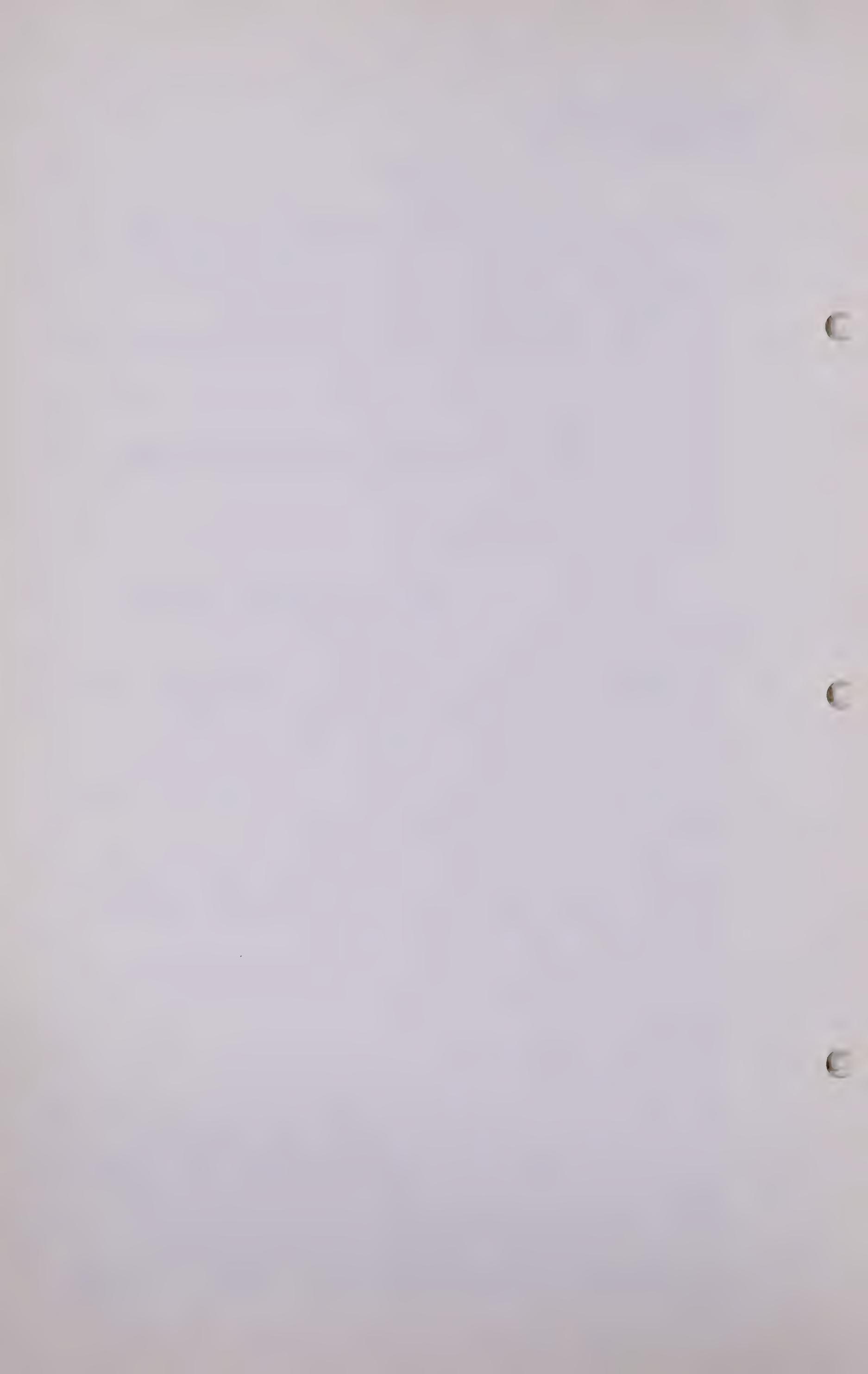
A I believe I mentioned the Natural Gas Pipeline of America and City Service Gas Company lines. The third one would be the Trunk Line Gas Supply Company.

Q Perhaps as we are going along you will tell us when this was done?

A It would be about 1949.

Q For all three of the ones you mentioned?

A No, the others were 1946. Trunk Line Gas Supply, the line from the gulf coast of Louisiana and the very southwest corner of Texas to the general vicinity of Indiana and is a connection to the Panhandle Eastern Pipeline system which goes into Michigan in the vicinity of Detroit.



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The firm of DeGolyer and MacNaughton, including myself, prepared their reserve study. Initial delivery should begin very shortly. The total reserves involved were approximately 2 trillion cubic feet from 8 to 10 fields. Another more recent pipeline reserve study was the study for the El Paso Natural Gas Company, 1950, the construction of their line to join with Pacific Gas Company line with Topeko and Arizona involving the estimates of the reserves of the Cretaceous fields of the San Juan basin and the Pennsylvania Gas of Barker Creek. The estimates involved a total of something on the order of 2 trillion plus feet. The line is completed and intial delivery should begin this month. There have been in addition a number of other pipeline reserves studies involving the Trans-Continental Pipeline, the initial studies of the large fields in southwest Texas, and Texas Eastern studies on gas stores in Pennsylvania and reserves of Louisiana and Texas, Cartage field reserves, and perhaps six or eight more of recent origin which by diligent thought searching I could talk about.

Q That is both for you and your firm?

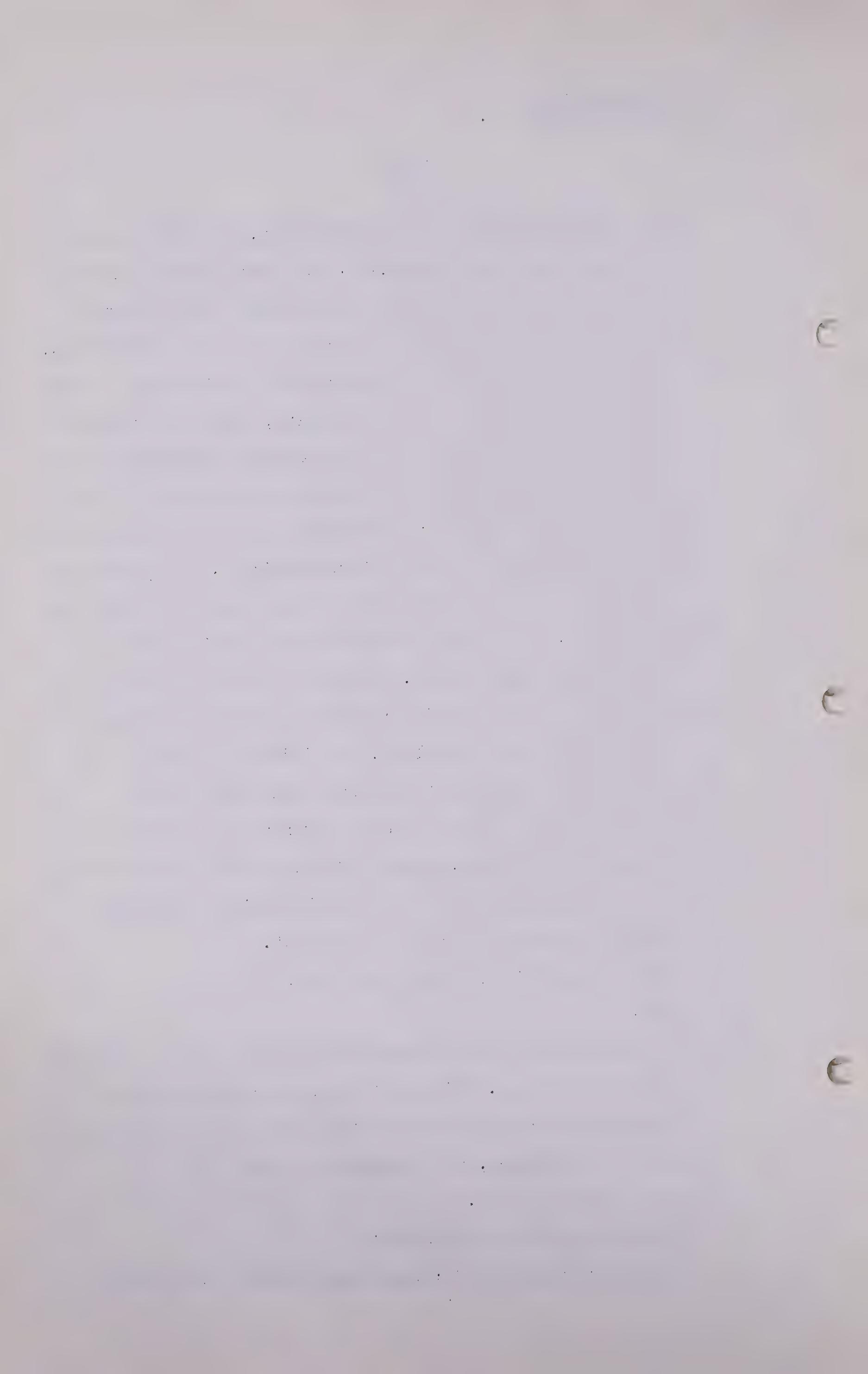
A Yes.

Q I would like to ask you another question on this question of connate water. First of all, your estimates as to connate water were obtained from a study of electrologs and core analyses, am I correct in that?

A Core analyses only.

Q Electrologs do not help any?

A There are methods of calculating connate water from



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electrologs providing you have sufficient data to serve as a perimeter in calibrating the resistivity scales.

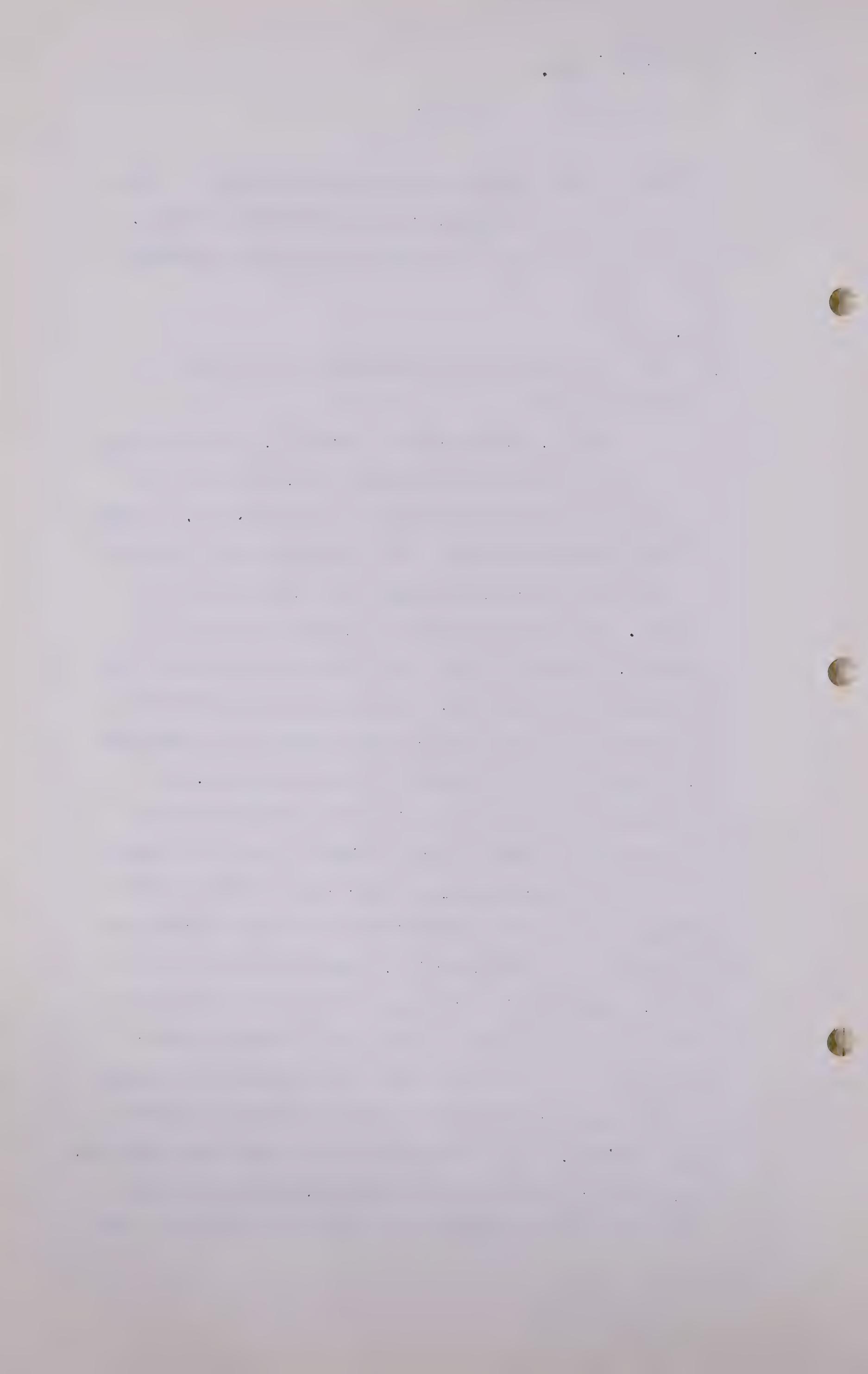
Q You tell us you made your estimates from core analyses only?

A Yes, sir.

Q And from that study of core analyses you arrived at a percentage of 45?

A That is correct. As we closed yesterday, I was looking for a correlation between permeability, porosity and connate water, which is the basis for the study. I might explain that we took all of the determinations from the core analyses which had permeability and porosity to measure. Many of the analyses only measured the bulk porosity. I made a correlation between permeability and connate water saturation. It becomes then a scattered distribution of points which when plotted on logarithmic paper tend to give a straight line correlation. We found from examining all of the core analyses for the pay thicknesses which we had estimated that the average porosity was approximately 20 per cent and the average permeability for that porosity and those pay thicknesses approximately 50 millidarcies, then the correlation between 50 millidarcies and connate water yielded a range between 35 per cent and 50 per cent of connate water saturation. It shows then 45 at the higher side because we knew that our thicknesses included some low permeability ranges. That is in essence the method we employed.

Q Now, I asked you about an assumption, that your 45 was wrong and that the figure that should have been used for



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connate water was 20 per cent.

A You asked me what the difference would be.

Q In the calculation of your reserves. Would I be right in saying that your reserves would be increased by 45 per cent under those circumstances?

A It would be the difference between 75 and 55 per cent in the volumetric formula.

Q Well, tell me, when you are computing reserves and your top 45 per cent connate water, do you use a factor of 55 in making the calculation?

A Yes, sir. You see, we want to get the remaining gas saturation in the porosity, which would be 100 minus the connate water.

Q Then when you are using a percentage of connate water of 20 per cent, do you use a factor of 80?

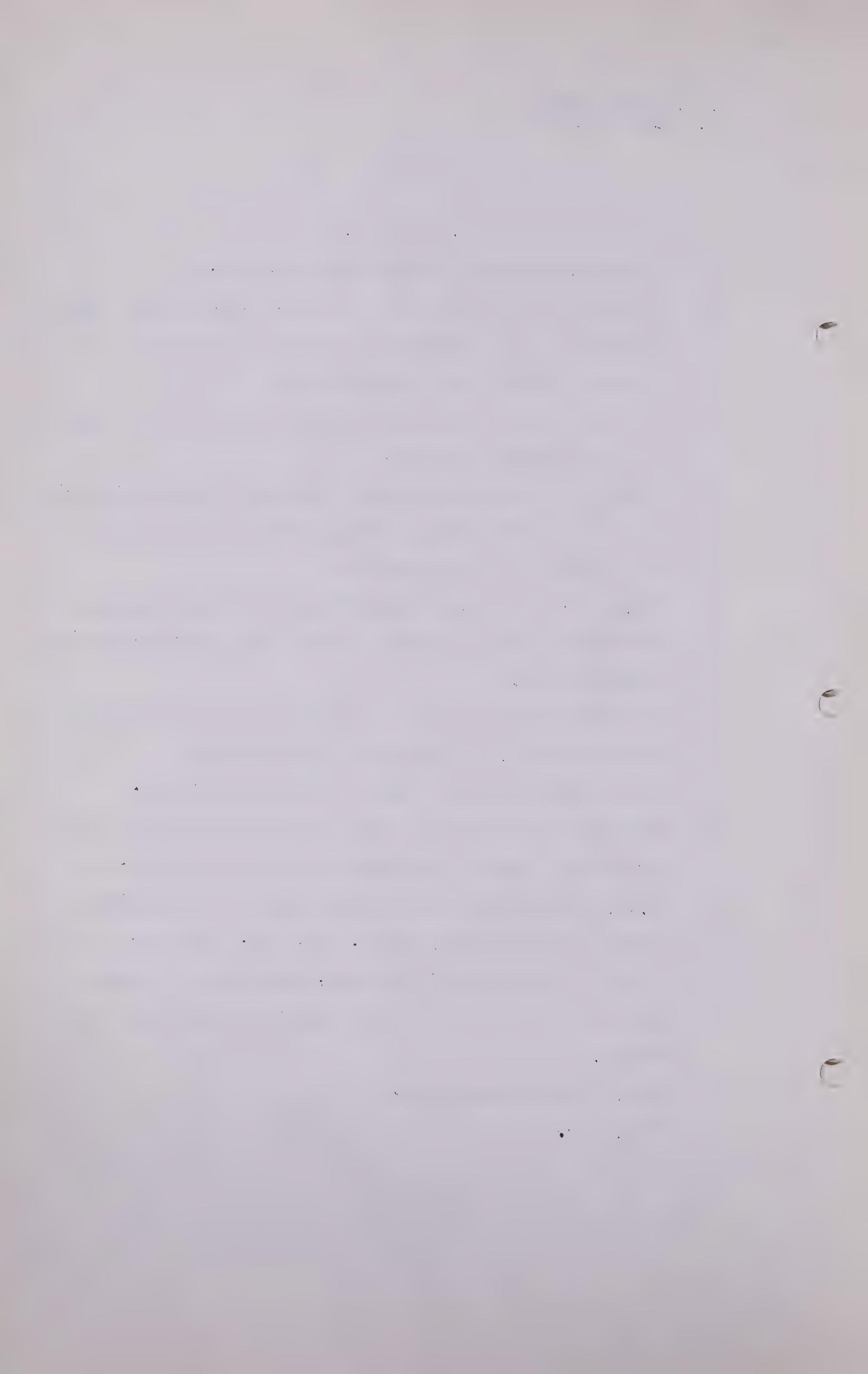
A Use a factor of 80. That is the gas saturation.

Q My suggestion is to you then that if you use 80 instead of 55 as a factor your result will be 80 over 55, or 1.45, or an addition of 45 per cent to your reserves?

A That is approximately right, yes, sir. However, that is only to the acre foot recovery, not to the reserves, necessarily, only if all the other factors remain constant.

Q Yes, I am assuming that.

A Yes, sir.



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Q Now, if you will come to the area in the Viking Field, you have used 496,806 acres?

A I believe that is correct for the proved area.

Q And you know that Mr. Davis in his computations of the reserves in the Viking Field has used an acreage of 245,000 odd?

A That is correct.

Q And you know where his area of 245,000 odd is, don't you?

A Yes, sir. I have transcribed that area on to my work map.

Q And you may have told us this, I think perhaps you have, but I would like to know why you include the area between the 245,000 odd of Mr. Davis and the 496,000 that you have computed?

A Well, I would like to do it in some detail.

Q Yes?

A Referring to page 6 of Exhibit 10, Census Division 10?

Q Yes, all right?

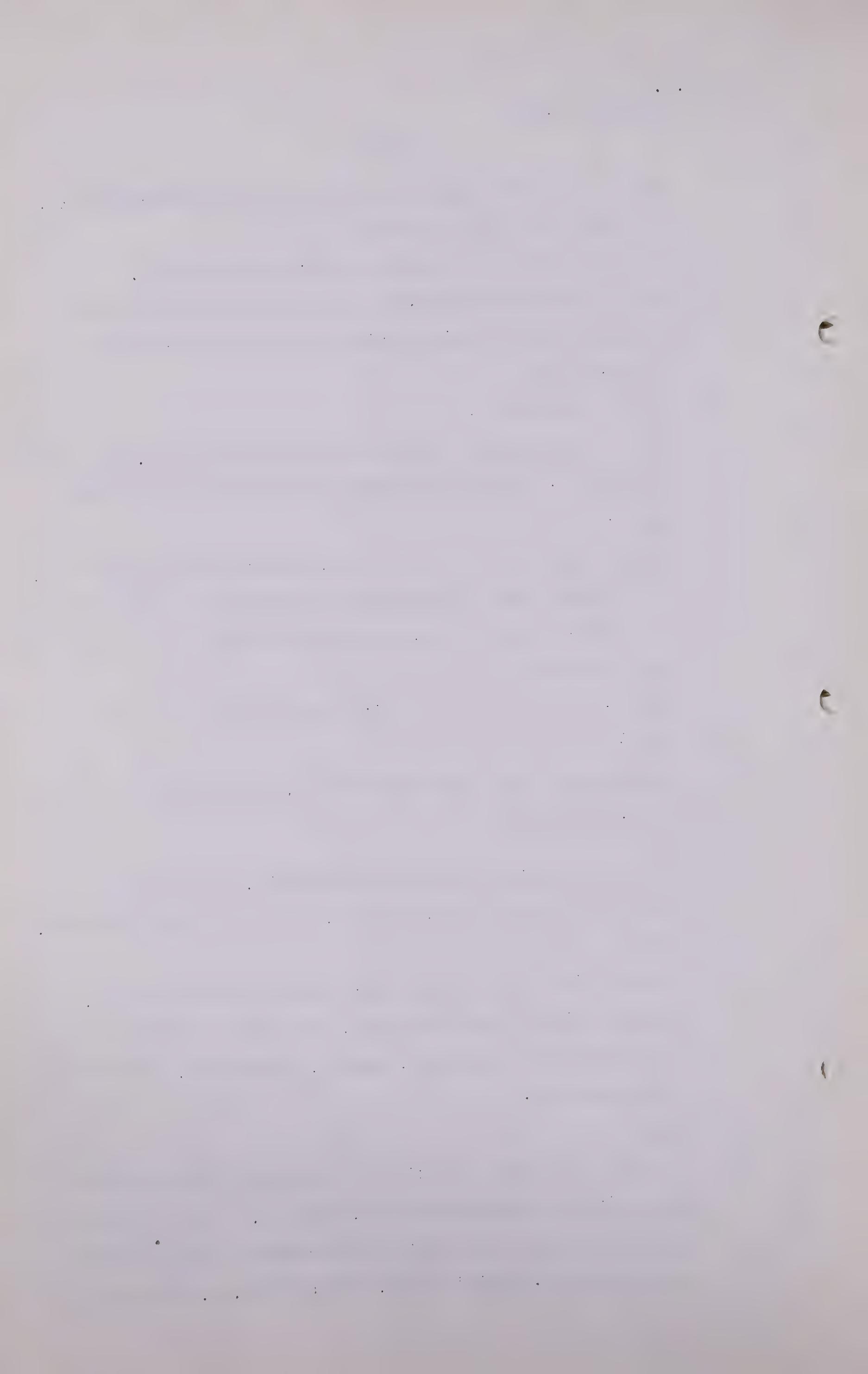
A If you will refer to that map exhibit, I would like to start in Township 49, Range 9, West of the 4th Meridian.

Q Yes?

A I will first give you the approximate position of Mr. Davis's line in that Township. It roughly includes the southwest three sections, namely, Sections 4, 5 and 6 in that Township.

Q Yes?

A You will note that our line of the proved limit takes in essentially all of Township 49, Range 9. You will note also that there is a well in the centre of the township outside of Mr. Davis's line, labelled No. 4. That well



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tested 873,000 cubic feet of gas on a drillstem test. That is part of the gas reservoir. We, therefore, included that part of the gas reservoir in our reserve estimates. We can see no point in eliminating gas saturation from a detailed comprehensive study of a gas field.

Q Yes?

A If we may now go to Township 48, Range 8, West.

Q Yes?

A We have a well located in the centre north half of the township with 146,000 cubic feet on a drillstem test, well No. 12, and that is in our area of possible gas saturation. It is outside of Mr. Davis's limits of computation. Going southward in the township.....

Q Now, just one moment, Mr. Dougherty, I am asking you about the difference between your proven 496,000 odd acres and Mr. Davis's 245,000?

A That is correct.

Q And this well that you are referring to is outside even your proven area?

A Yes, but we have a computation for possible.

Q I will be coming to the possible, and I will ask you to confine yourself to the proven?

A Yes, sir. Referring then to Township 47, Range 9, West, well No. 6 in the southeast corner of the Township, is outside of Mr. Davis's limits by a mile approximately, and inside the limits as set by DeGolyer and McNaughton by approximately 6 miles. That well tested  $6\frac{1}{2}$  million cubic feet of gas and some water.

Q Just a moment. That is where?



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A It is in section.....

Q 20, is it?

A No, Section 11. Well No. 6 in the southeast corner.

Q I see, all right?

A We estimate something on the order of 5 feet of sand in that well. In other words, there is a substantial gas saturation, and a portion of the reservoir.

Q Yes.

A Proceeding to Township 6, Range 8, West, we have well No. 16 located in Section 6, the southwest corner of the township, which is on Mr.Davis's limits. That well tested 2.1 million cubic feet per day. We estimate 13 feet of sand. That well is 6 miles within our limits.

Q Yes?

A Proceeding to Township 45, there are a number of wells shown there.

Q Which?

A Township 45, Range 8.

Q Excuse me a moment, Mr.Dougherty?

A In the Fabyan area there. There are a number of wells shown which are productive of gas from the Viking sand.

Q Just a moment, Mr.Dougherty, please. In 46-8?

A 45.

Q In 46-8 you referred to the well in Section 6?

A Yes, sir.

Q There is a well indicated there up above that?

A Oh, yes, sir. That is the Scovil Lake well, the D-1 discovery of Imperial. That well had about 3 feet of Viking Sand. It has low permeability and is a portion of the reservoir in our opinion.



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Q Yes. Now, then, you were going to 45-8?

A Yes, sir. The wells in 45-8, of which there are something in excess of 5 or 6, in the southeast quarter of that township, producing gas from the Viking sand.

Q Yes?

A As you will note from the pressure contours on page 6 there has been gas production in the amount to draw the pressure down to 600 pounds, plus or minus, in the very southeast portion of that township. All of those wells are outside of Mr. Davis's limit. However, we consider them part of the Viking-Kinsella-Fabyan reservoir.

Q Is it true that Mr. Davis computed those wells with respect to another field which he described as the Fabyan?

A That may be. I have no knowledge of that.

Q If you assume that that is so, then we will proceed. Mr. Davis will speak with regard to that?

A Yes, sir.

Q I am suggesting to you that he included those?

A You will note, however, that there are no dry holes between those wells and the wells in the Viking.

Q Will you just proceed?

A Yes, sir.

Q That is one of the reasons, is it, why you included this whole area in the Viking-Kinsella Field?

A Oh, yes, sir.

Q Yes?

A Township 44, Range 8, West of 4, you will note one well in Section 29 drilled in 1943, and that well produced 887 MCF on test. We estimate 11 feet of sand. We included that within the limits of the greater Viking-Kinsella-



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Fabyan Field.

Q Yes?

A That well is 6 to 8 miles southeast of Mr. Davis's limits. Referring now to township 45....

Q Just a moment, Mr. Dougherty, please. You are talking about these wells down in the southeast corner of your area, and I would like you to tell me roughly in what township and range Mr. Davis's boundary of the Viking-Kinsella Field comes?

A Mr. Davis's limits in the southeast direction just cuts into the northwest corner of Township 45, Range 8.

Q Northwest corner of 45, Range 10?

A Range 8.

Q Range 8?

A Yes. It would be just below Well No. 16 in Township 46, Range 8.

Q And then from there it runs across where?

A It runs across through the town of Irma.

Q Yes?

A And then 1 mile north of the town of Jarrow on the rail line.

Q I see?

A And then within a quarter of a mile of the town of Kinsella.

Q Yes?

A Within a quarter of a mile of the town of Phillips.

Q Yes? That is all right, thanks.

A Yes, sir.

Q Go ahead?

A Referring now to Township 45, Range 9, Mr. Davis's limits pass between the two wells shown in Section 28. That is



J . F. Dougherty,  
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the section with 2 wells and 2 locations shown. The northernmost well, No. 19, is a gas well having very good porosity and permeability of a character higher than any analysis we have seen in the field. I would not, therefore, consider it to be an edge well. The well to the south, No. 14, outside of Mr. Davis's limits, tested 2.2 million cubic feet on drillstem tests in the Viking.

Q Yes?

A We consider that to be substantially within the proved limits of the field. If you will note our limit line runs  $2\frac{1}{2}$  to 3 miles south of Mr. Davis's limits.

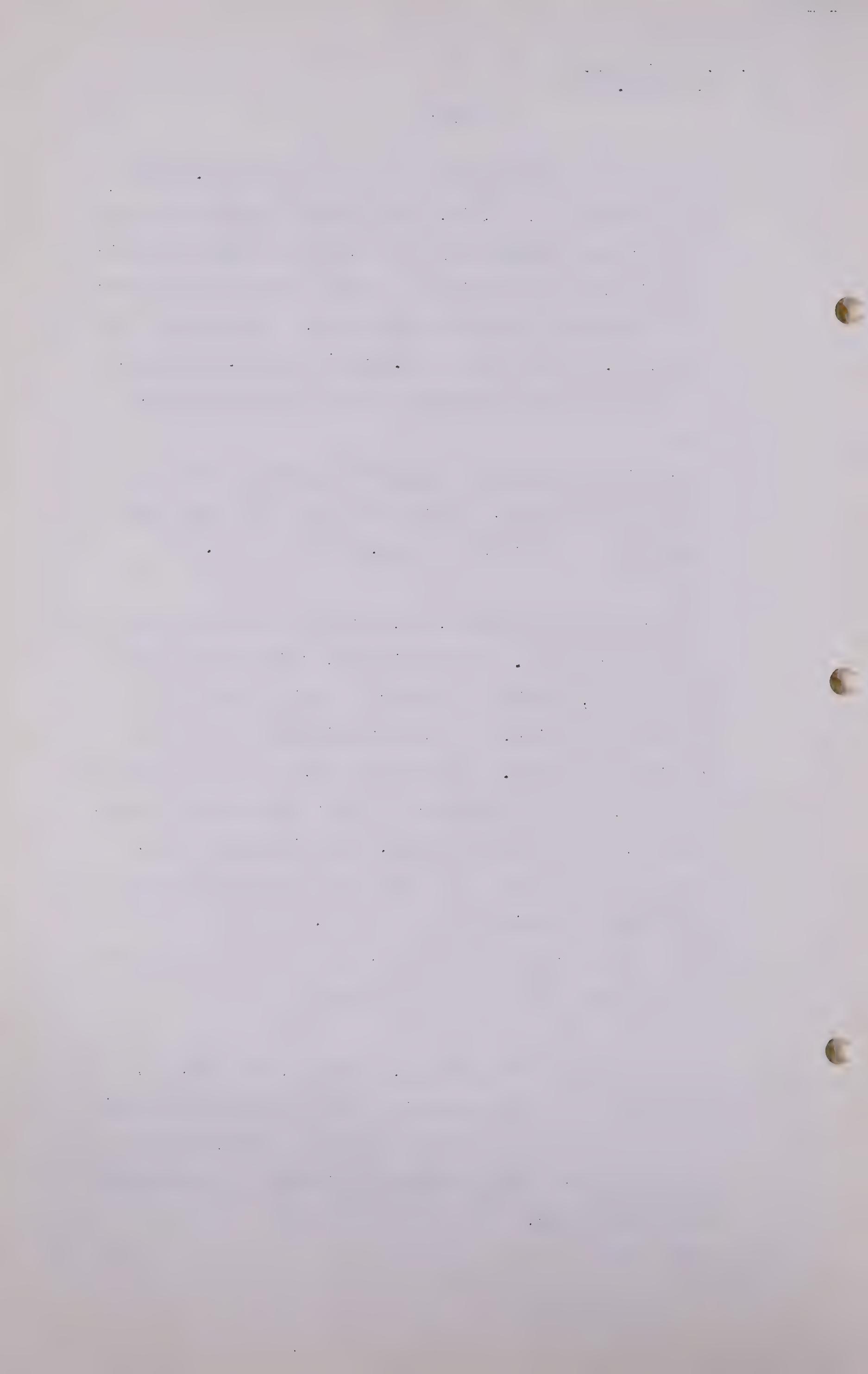
Q Yes?

A Referring now to Township 45, Range 10, we have a well noted there as No. 1 in Section 20, referred to as the Jarrow well, which we consider as having 8 feet of net gas saturation. I do not think the volume of gas is on this map. No, I do not have the gas volume on this map, but I do remember it was a substantial volume. Well No. 18, to the northeast, was drillstem tested, but no pipe was set. It has a low permeability section and totals something around 16 feet. We think that that area is gas-productive and gas-saturated, and consider it within the limits of the reservoir.

Q Yes?

A Referring now to Township 46, Range 11, Well No. 17, the only well in the township, tested 1.21 million cubic feet. That well is  $1\frac{1}{2}$  miles southwest of Mr. Davis's limit and 1 or 2 miles within the limits of the DeGolyer-McNaughton study.

Q Yes?



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A Referring now to Township 47, Range 12, we have well No. 22 in the south half of the boundary, close to the rail line. This well is  $1\frac{1}{2}$  miles southeast of Mr. Davis's limits and 2 miles within our limit. We have a notation of a test of 450 Mcf of gas on drillstem tests. We estimated approximately 12 feet of sand.

Q DR. GOVIER: What is the present state of that well, Mr. Dougherty?

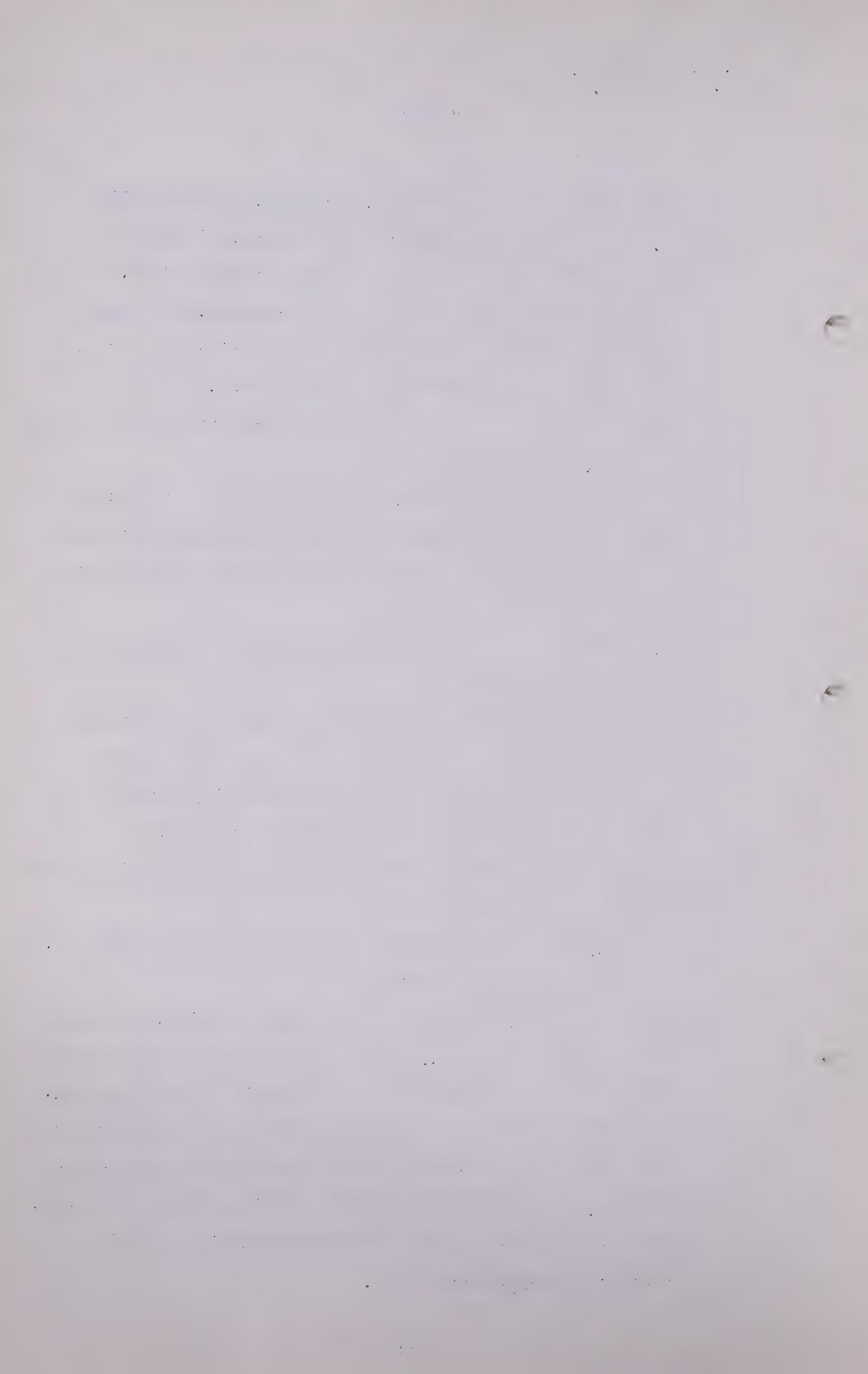
A I believe it is abandoned. I do not believe the pipe was set due to the apparent opinion that anything under 2 million cubic feet was not commercial at whatever time that well was drilled.

Q MR. STEER: You would have connected it to the system, would you?

A I think I would have completed it because of the recent experience we have got in other fields which suggests that some of these sands of low permeability can be increased considerably in an effective gas field. I would not rule out any well in as early a stage of development as the Viking-Kinsella.

Q In fact, your recommendation would be that this whole 496,000 odd acres should be drilled?

A Not necessarily, but of a fairly close density, perhaps 2 or 3 sections per well, because it has been my observation over a number of years that the economics of gas changes. I remember a time not so long ago when a 5 million cubic feet well in the Panhandle Field was considered sub-commercial. At that time the Hugoton Field was not developed, and yet the average well in the Hugoton Field now is a 5 million backpressure well.



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Q You said not the same density, not the same density as the fields from which the company gets its major supply now, is that what you mean?

A Yes, in places where there are thinner sands it is preferred to have a wider density in order to get a wider range and to maintain deliverability by the influx of gas and maintenance of pressure.

Q Is it your view that in the area outlined by Mr.Davis we have the thicker sands and in this outside area, if I may call it so, which has been incorporated by you, the sands become gradually thinner from the centre out?

A Yes, that is quite true. Mr.Davis's area takes the cream out.

Q Yes?

A But we do not consider that to be the limits of the reservoir.

Q You were talking about Township 50, Range 12?

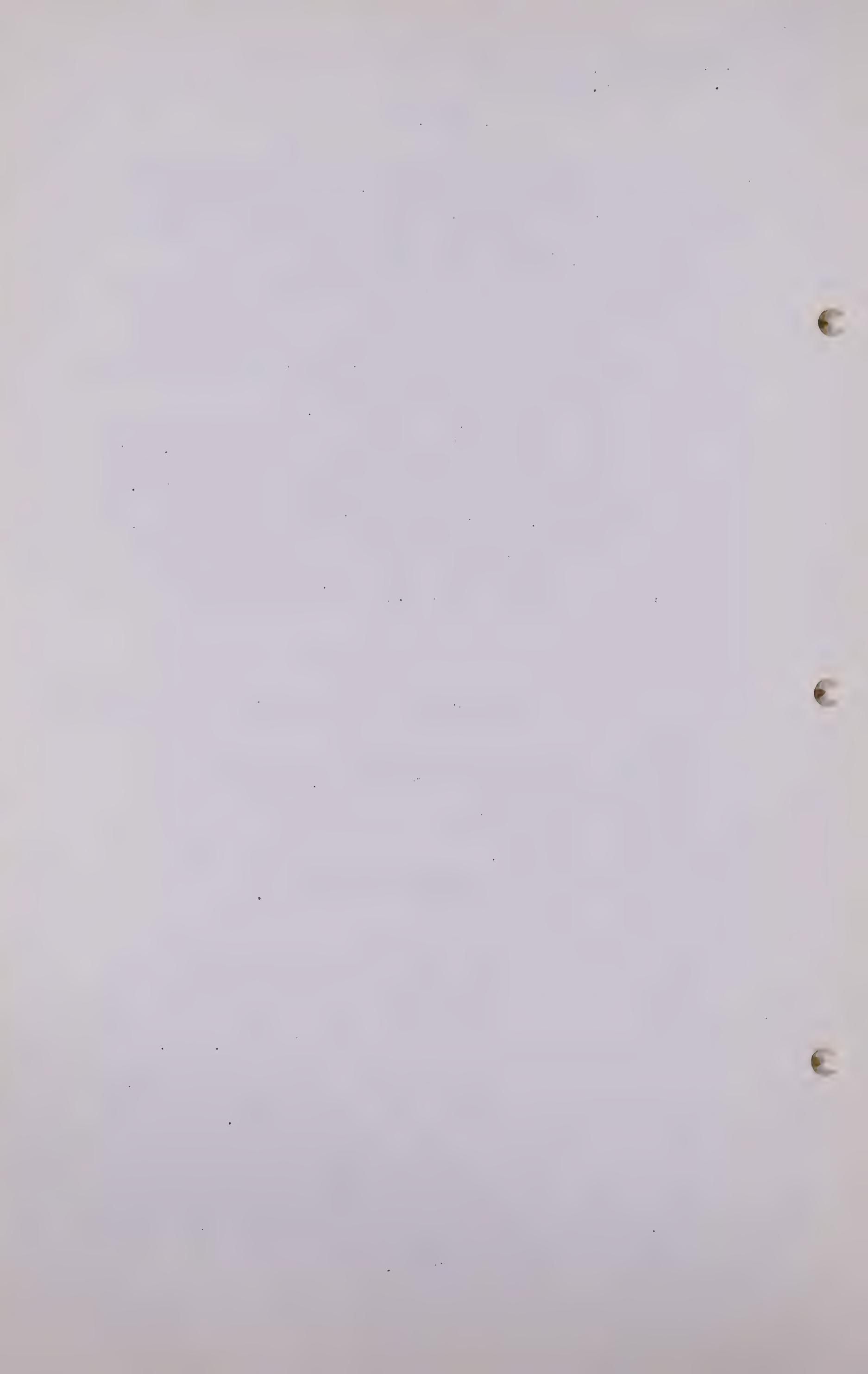
A Township 47, Range 12.

Q Oh, yes, I am sorry.

A Now, referring to Township 48, Range 13.

Q Yes?

A There are three wells shown in the easternmost tier of sections, or row of sections, the southernmost one labelled No. 1 came as a 9 million foot well in 1914. Mr.Davis's line passes within 1/8 of a mile or so of that well. Our limits are several miles west of that line. We feel that the reservoir extends at least that far in view of the original well completed in 1914 for 9 million cubic feet. It is an old cable tool well and the data on the thickness of sand is unknown.



J. F. Dougherty,  
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Q I note, however, with regard to the old Viking wells on your page 5 you have given those sand thicknesses?

A Some of them.

Q How were they estimated?

A The ones on which we have given sand thicknesses up in the old Viking area are based largely upon the notations of Dr. Liesemer from observations made some years back as they checked against the electrical log correlations on either side.

Q Well, you have made no personal study of the thicknesses of those sands?

A They were drilled with cable tools and there is no way to determine that at the present time.

Q That is what I understand.

MR. C. E. SMITH: Excuse me a moment, Mr. Steer. When we are talking about Dr. Liesemer, is that the man who gave evidence here before who is usually known as "Goldie"?

A I understand that. I may have promoted him.

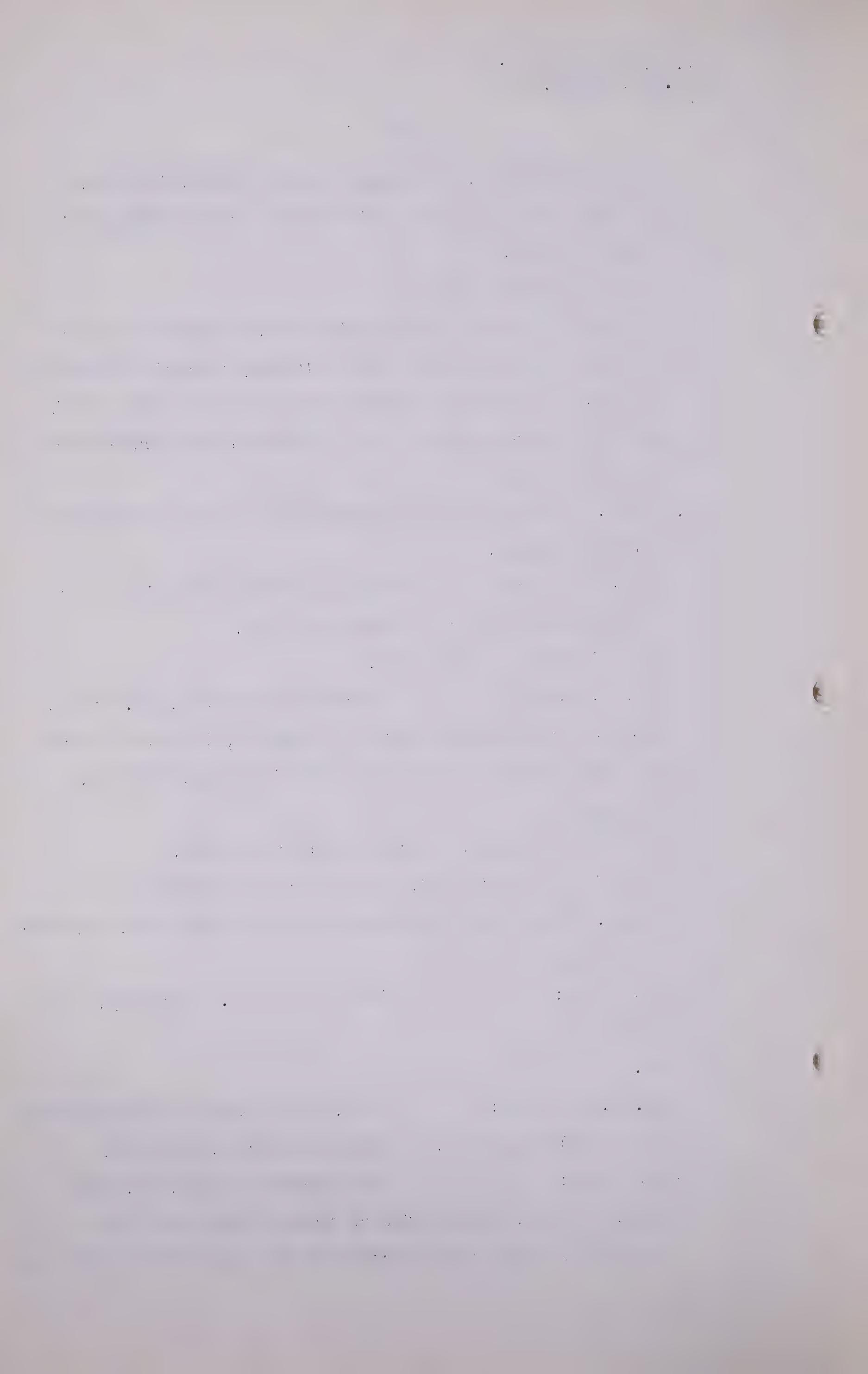
Q I am just trying to find out. I am not trying to be funny. I was just wondering whether we had a Dr. Liesemer that I did not hear of.

Q MR. STEER: You are not Dr. Dougherty, are you?

A No.

MR. C. E. SMITH: Well, it is only the one Liesemer we are talking about, as long as we all understand.

Q MR. STEER: All I wanted to get, Mr. Dougherty, is this, that so far as these Viking wells are concerned, these sand thicknesses are inserted on your map



J. F. Dougherty,  
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by your reference to Dr. or Mr. Liesemer's report?

A Yes, that is right.

Q There is no personal computation made by you at all?

A Not on the old cable tool wells, that is correct.

Q Now, you were talking about these three wells in the eastern part, were you?

A Yes, sir. I would like now to refer to Township 49.

Q I wonder, before you do that, if you would refer to 47, Range 13?

A Yes, sir.

Q There is the Imperial Viking No. 1 there?

A That is outside of our proved limits, and I was not going to refer to it in view of your remarks a few minutes ago.

Q What is that?

A I was not going to refer to the possible area. I understood you wished my statement to be restricted to the proven area.

Q That is right. Now, tell me where the nearest producing well to the east of that Imperial Viking well is, and is that a dry hole?

A It was not completed but had 3 feet of sand.

Q Yes?

A It is part of the reservoir.

Q Now, where is the nearest well to the east of that?

A Which way to the east?

Q North or south, I do not care?

A Well, it would be approximately 5 to 8, oh, about 8 miles. There are several wells in Township 48, Range 12, and the No. 22 in Township 47, Range 12.

Q Your line is a good deal closer, assuming that to be a dry



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hole, your line was a good deal closer to that dry hole than it is to the producing wells to which you have referred?

A Yes, sir. The little bulge in that line is based on an interpretation from a structural map, which would indicate that the area in the general vicinity of there with relation to the Viking, is going to be high structurally, contoured with the well, so that there is a likelihood of increased sand thickness. Our limits are not commercial limits. We are dealing with the reservoir. We are not interested where someone wants to drill particularly, depending on local economic considerations.

Q Yes, but when we are considering the reserves of the Viking Field, surely we are having a commercial inquiry, aren't we?

A You cannot estimate the reserves of each reservoir by pressure decline unless you take in the reservoir limits. Boyle's Law holds that the volume is constant.

Q Do I understand that the 496,000 odd acres would not be described by you as commercial gas?

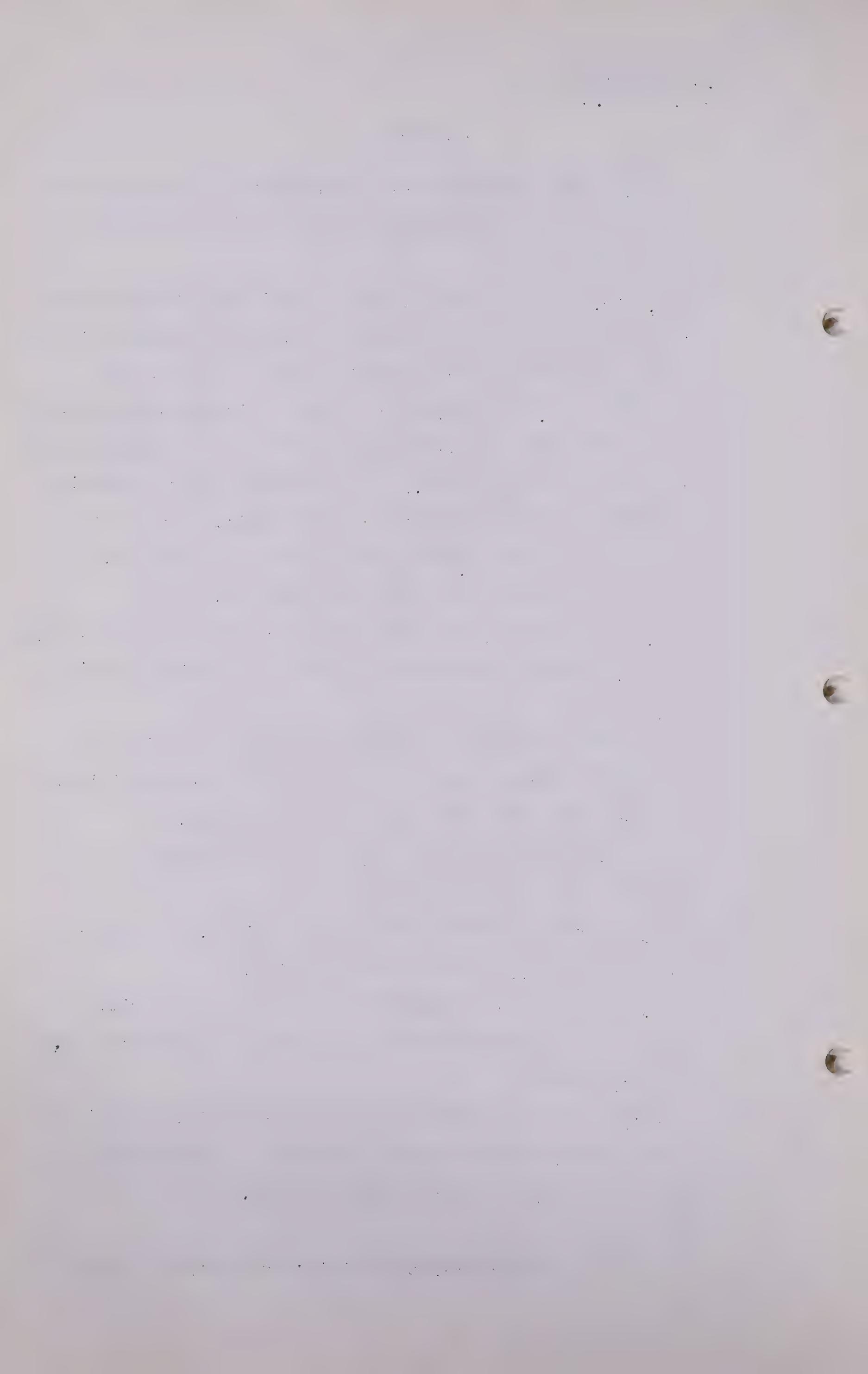
A Yes, I think it can be commercially drained, not necessarily by a well in a specific location.

Q Yes. What you are suggesting is that the wells drilled in the more productive area will drain the gas from these outlying areas?

A I think there should be additional wells drilled out in these intervening areas much like some of the stepouts recently completed in the Kinsella area.

Q Yes?

A In order to make a maximum efficient recovery of the gas



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in place in the reservoir.

Q What do you think would be the proper spacing of wells in the thicker sands of this field?

A I think they are too closely spaced to the old Viking area, and perhaps very well spaced in the Kinsella area.

Q And in the Kinsella area there is a well to what?

A Those four townships centring around 48 and 47, and Ranges 11 and 10, it would look as if there is  $2\frac{1}{2}$  to 3 sections per well. I think that is a very, very good program.

Q Didn't you tell me a few minutes ago that that is what you would advocate as to the drilling in what I am going to call the marginal area?

A I think it would be that as a minimum, but the spacing might be wider. That would depend on conditions as you found out the details of the sand thickness and the productivity of the wells, and you would adjust that then.

Q But up to date, I might be quite wrong, but my recollection is that you told us that in this outside area you would drill a well through every 2 or 3 sections, and then we find that in the thick sands the Company had drilled wells around that?

A Yes, but they are now in fill drilling.

Q Pardon?

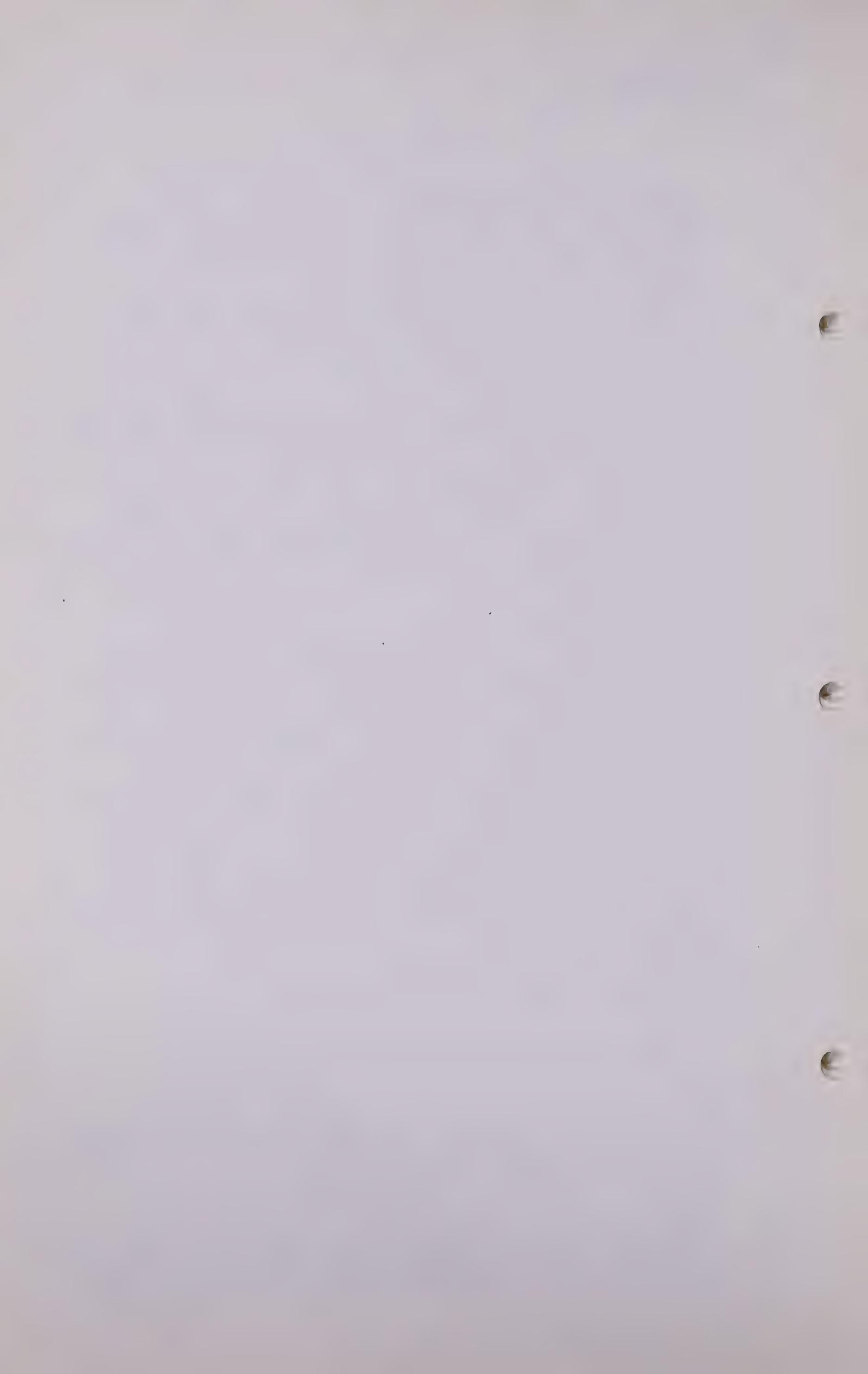
A They are now in fill drilling, reducing that space.

Q Yes?

A So that what the ultimate space will be will be a function more of deliverability than recovery.

Q Yes?

A I believe I was starting to mention Township 49, Range 13, West of the 4th. I might indicate that Mr. Davis's limit



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arcs through the eastern half of that township and does not quite reach the northeast corner of the township.

You will note well No. 10 located in the northwest quarter of that township in approximately Section 29.

That well was completed in 5-13-46. That is its date.

Q Yes?

A With an open flow of 1.36 million cubic feet.

Q Yes?

A The initial pressure in 1947 was 648 pounds bottom pressure absolute, pounds per square inch absolute, and we estimated from the electrical log and the core analyses 9 feet of sand. We considered that to be a very distinct part of the reservoir. That is a mile and a half of part of Mr. Davis's limit, and about 2 miles within the closest extension of our limit. That well is the basis for giving some indication of the magnitude of the drainage in the old Viking area, because its pressure came in slightly below the original virgin reservoir pressure.

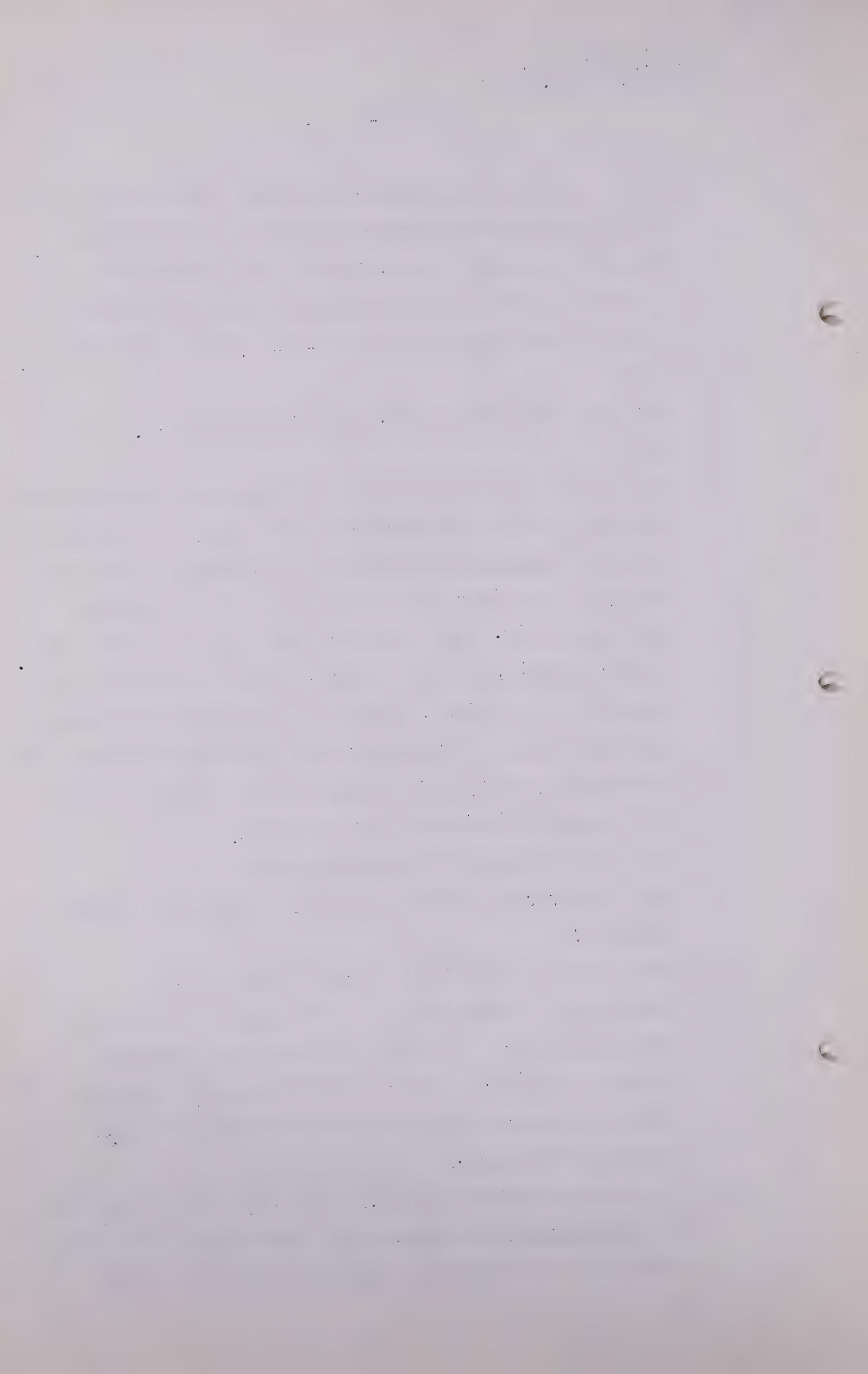
Q What was the original virgin pressure?

A 810, 910 p.s.i.a. bottom pressure. That is the deviated pressure.

Q What do you say was the pressure of this well?

A 648 pounds. I would have to check that to see if it is deviated or not. It might be bottom hole absolute without deviation. In that case, comparable original reservoir pressure would be around 810 pounds in that portion of the field.

Q I have some figures here, Mr. Dougherty, which I will have to substantiate, of course, but I have figures here which show that this well had a pressure when it was first



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drilled in 1946 of 609.5 pounds?

A That would be wellhead gauge.

Q Very well, but in 1947 it fell to 601, and it was not produced, it was closed in, you agree with that?

A Yes, I agree.

Q Yes. Then it fell in '47 to 601, it fell in '48 to 595.5, it fell in 1929 to 590.5, and it fell in 1950 to 585?

A That is correct.

Q Yes?

A That is exactly as I pointed out, that it was being drained by the production of Viking as part of the reservoir.

Q Quite so. All right, Mr. Dougherty?

A Referring to Township 50, Range 13, we have two wells, both of which had limited sand development. Well No. 2 we estimate about 2 feet. That is the well in the southwest, the southeast corner of the township. And well No. 21, up towards the northwest corner of the township, which we note very poor sand development, we made a little inquiry with regard to it but there was no proved gas, and we did not include those wells within our proved limits.

Q You said 3 feet in the southeast corner?

A 2 feet, plus or minus.

Q Yes, 2 feet.

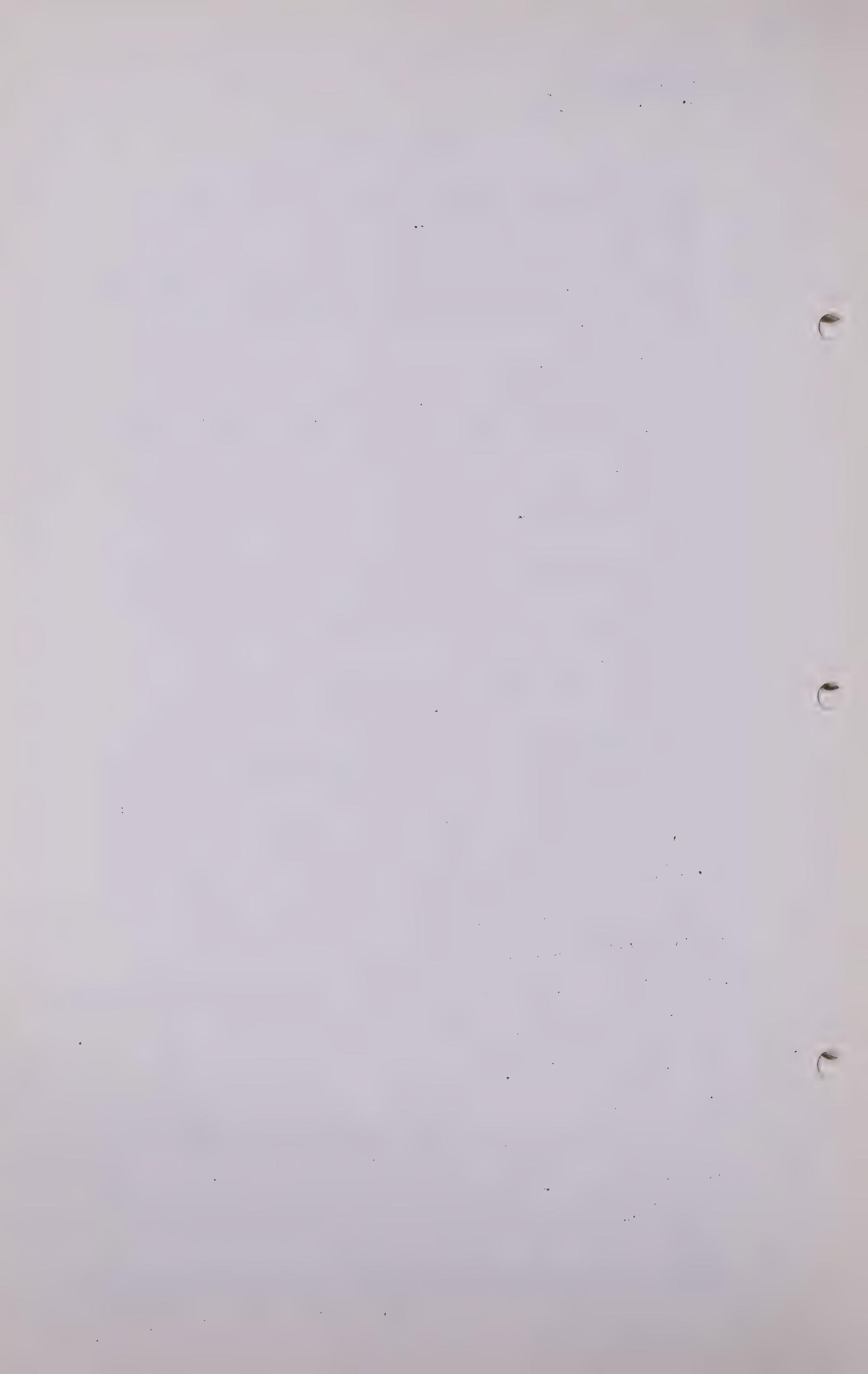
A I believe it says 2 feet under the notation there.

Q Yes, that is right.

A On the well.

Q Yes?

A Referring to Township 50, Range 12, we had the Ranfurly well,

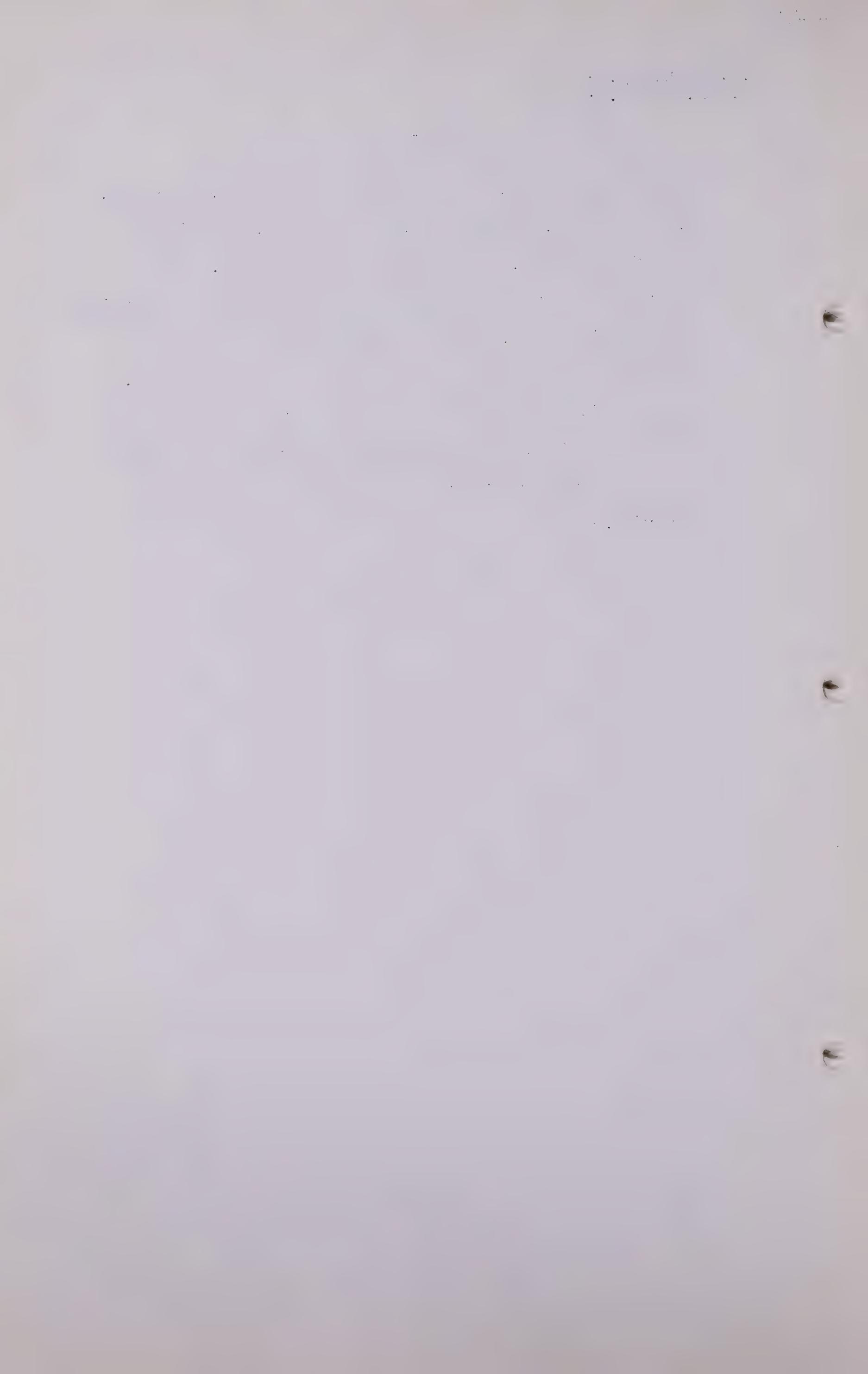


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Texaco Superior No. 1 Ranfurly in Section 31, I believe, no, Section 32, which drillstem tested 6.9 million cubic feet of gas, I believe in 1950 or 1949. We estimate 16 feet of Viking sand on the basis of electrical log determinations, and I brought you up to date in the early part of this Hearing on the No. 4 Ranfurly, completed just south of that well in the next section, which had limited sand development, because the cores were very shaly and tended to be of low permeable character.

(Go to page 463)



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A We think the reservoir will be somewhat spotted in this vicinity.

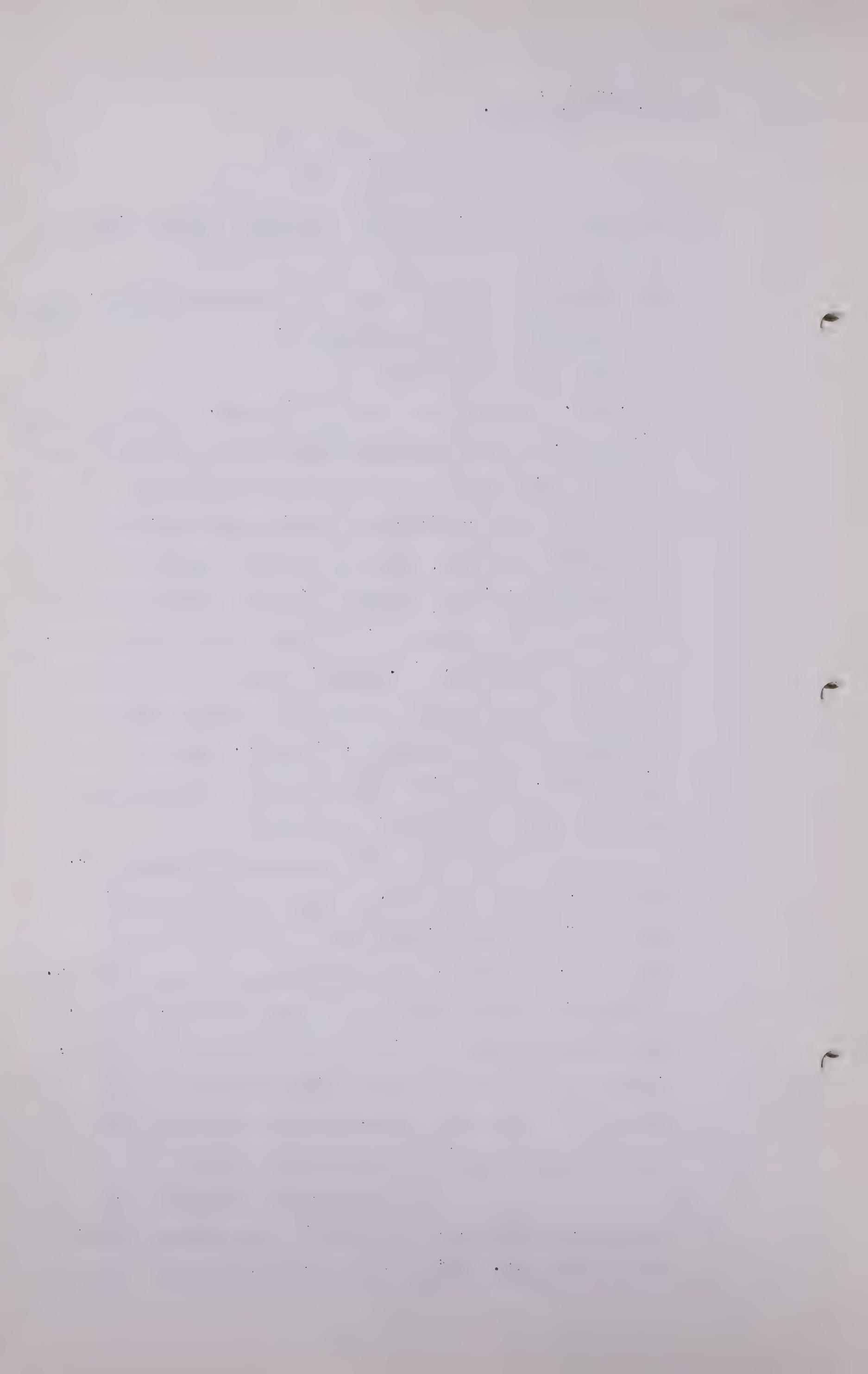
Q MR. GOODALL: Have you any record in that well in section 23 in the same township?

A The well near Birch Lake?

Q Yes, sir. That well was drilled in 1923. It had plus or minus 100,000 cubic feet according to the records we have. It was on the basis of that well that we thought there was a good likelihood, almost proved gas saturation in this general Ranfurly area which would connect up with the old Viking field. That is, the gas saturation will be extensive or would extend at least over those limits, as shown on our map. Mr. Davis's line for the proved commercial limits of his computations runs through the southern half of Township 49, Range 12, from 10 or 12 miles south, some 8 to 10 miles south of the Ranfurly well and south of the Birch Lake well.

Referring now to Township 49, Range 11, west of the 4th, we have one well in about the centre of the township, Well No. 8. That was a deep test, I believe, of Anglo-Canadian to the Devonian. On the drill stem test they recovered 490 Mcf. of gas. We estimate 3 foot of net sand thickness at that point, consider it to be a portion of the reservoir. Our limits lie a mile and a half north of that well, Mr. Davis's limit 2 miles south of that well.

Going now to Township 49, Range 10, we have Well No. 7 in the approximate centre of the township. This well was cored, porosity ranged



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in the vicinity of 21, no, 19 per cent or thereabouts. It is an old well with not too much data. Mr. Leisemer's notes indicated a small sand thickness and the core analysis would indicate that it was getting thin.

Q MR. STEER: I wonder what was the source of those notes, do you know?

A Mr. Beach obtained those notes from Mr. Leisemer and photostated them. They had statistical data running well back in the Kinsella history, and core analyses and some of the studies that the Board had made. I believe it is a formal Board report, actually, but I am not too sure of that.

Q I wonder why we would not have it. When was it made, have you any idea?

A I think there may be some dates on here, I am not quite sure.

Q You think there is a formal report in the Board's office by Mr. Leisemer from which this information was obtained?

A I do not know whether it is a formal report or not. There is no signature and no date so far as I can tell. They may be his own personal notes, I do not know.

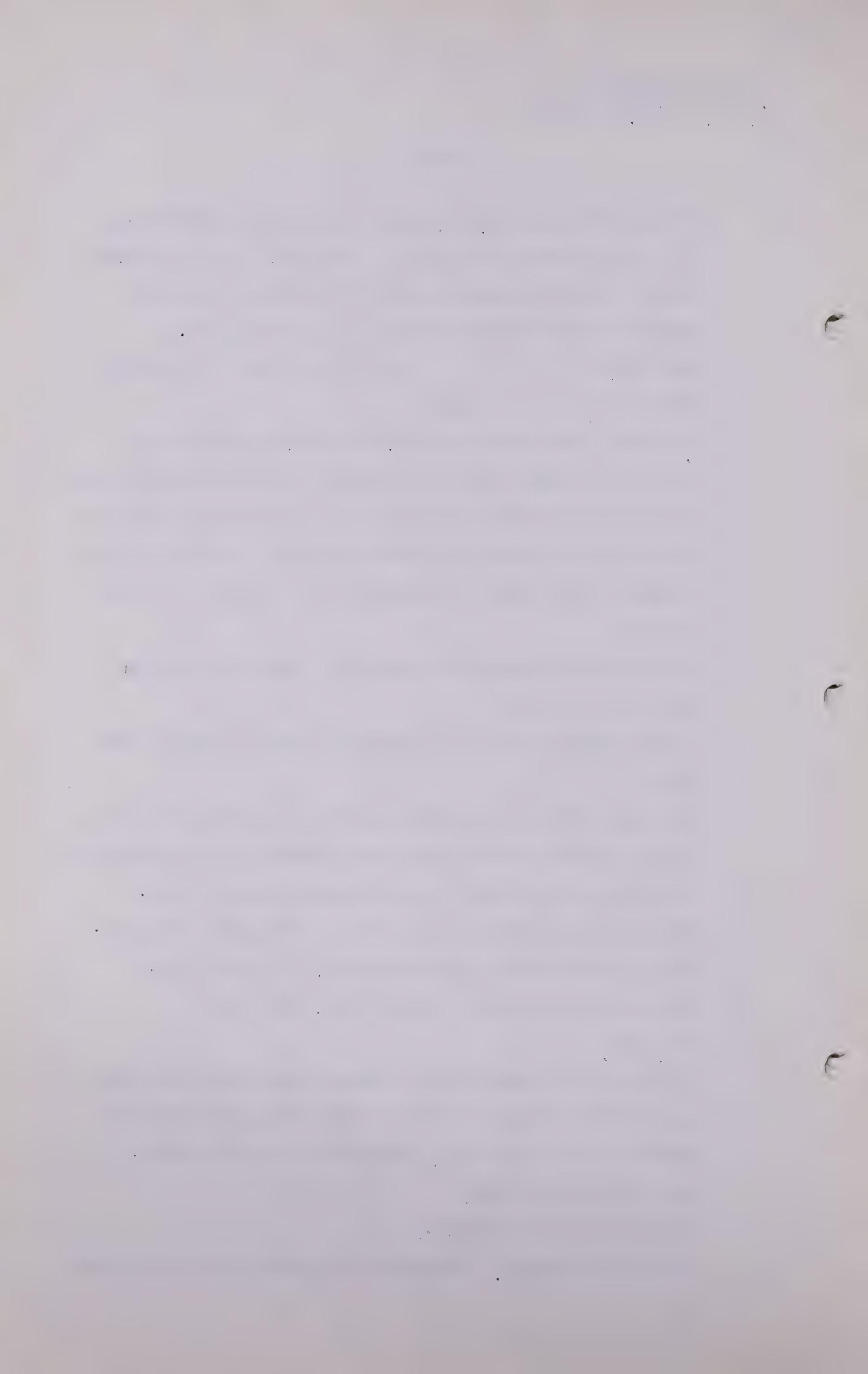
Q You have photostated copies there, have you?

A Yes, sir.

Q I wonder if I could look at them. I may ask the Board's permission to take a look at these and perhaps have a question or two from Mr. Dougherty at a later time. I have never seen them.

A You may have our records.

Q I am sure of that. I am sure if I asked you for anything



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else you would give it to me too. Go ahead.

A Township 49, Range 9, West 4th, we have Well No. 4 in the approximate centre of the township. This well lies something on the order of  $1\frac{1}{2}$  miles north of Mr. Davis's limits of computation which crosses the southwest corner of that township. That well tested 873,000 cubic feet. We estimate something on the order of 2 or 3 foot of net sand, apparently a fairly highly permeable sand for the limited thickness. We have shown our limits as lying some distance to the north and east of this well. We consider that to be an effective part of the reservoir so far as the performance of the reservoir is concerned. I believe that brings us back to the Well No. 12 in Township 48, Range 8, with which we started.

Q Yes, and that is a very clear explanation. I wonder if this would be so, Mr. Dougherty, that what you were talking about in this 496,000 acres is your estimate of gas saturation?

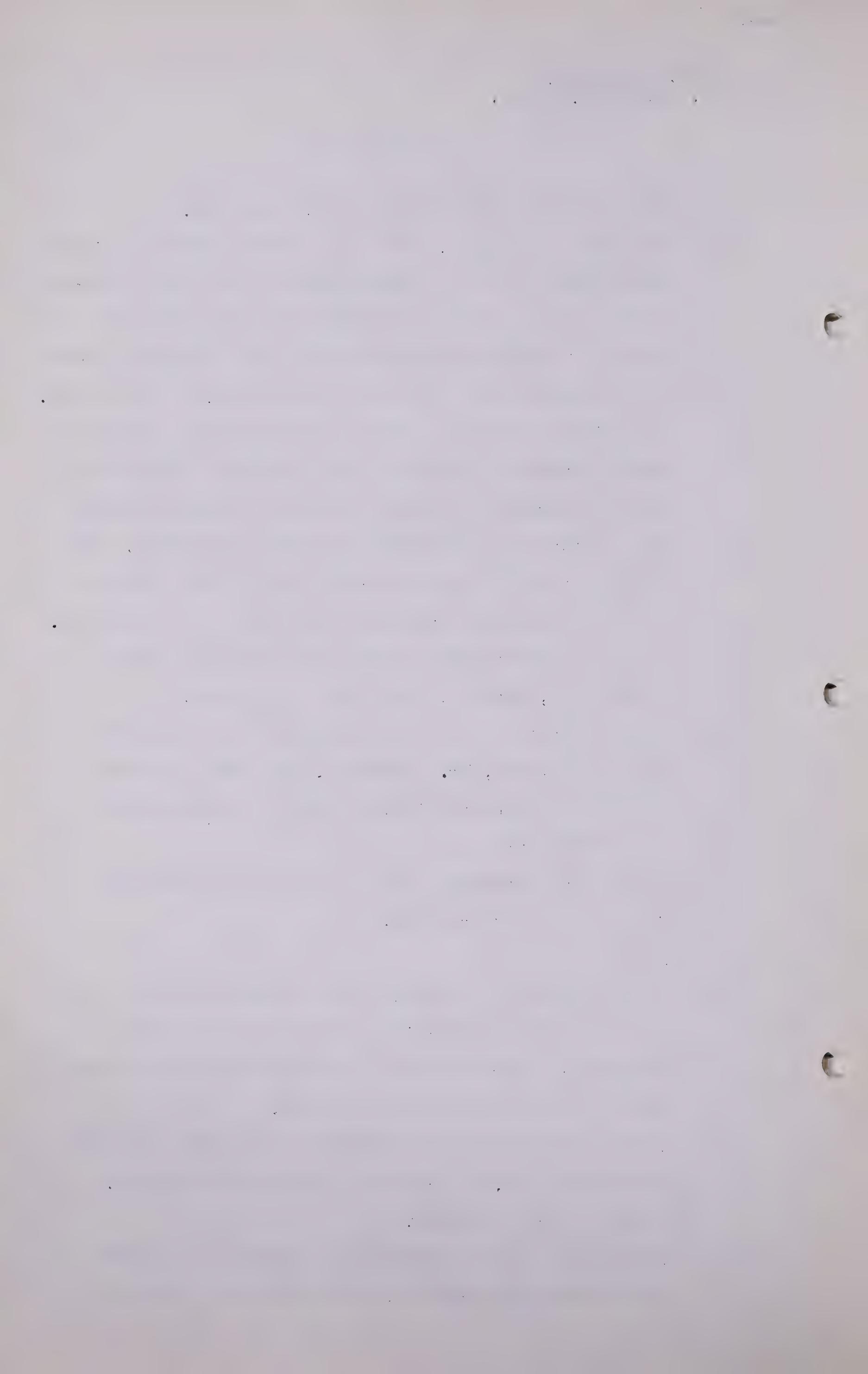
A That is the estimate of gas saturation in cases of 2 foot in thickness roughly.

Q Yes?

A Which we feel to be essentially the 95 per cent or 90 per cent of the effective gas reservoir and that no volumetric or pressure decline calculations can be made on any smaller area within validity.

Q Do you identify the gas saturated area which you told us about of 496,000 acres as identical with proven, commercial gas reserves?

A We have not put the connotation commercial in there in our thinking because unfortunately the reservoir



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makes no distinction between commercial and non-commercial but conforms to physical laws.

Q A man operating a gas distributing company has got to exercise his judgment in determining what part of these reserves are commercial?

A Where he might like to drill, but I would not limit my computations to an area that small in total gas saturation when estimating reserves.

Q If you were advising Northwestern Utilities Limited, which has the right to produce this area, you are going to tell Northwestern Utilities Limited that they have got the quantities of gas that your computations show in this whole area?

A Yes, sir.

Q And that by economical drilling methods all that gas can be recovered?

A Prudent and economical drilling over the next 50 years, that is right.

Q Yes. Now, I would like to take you back to Texas-Superior-Ranfurly in Section 32-50-12?

A Yes, sir.

Q That is a shut-in gas well, isn't it?

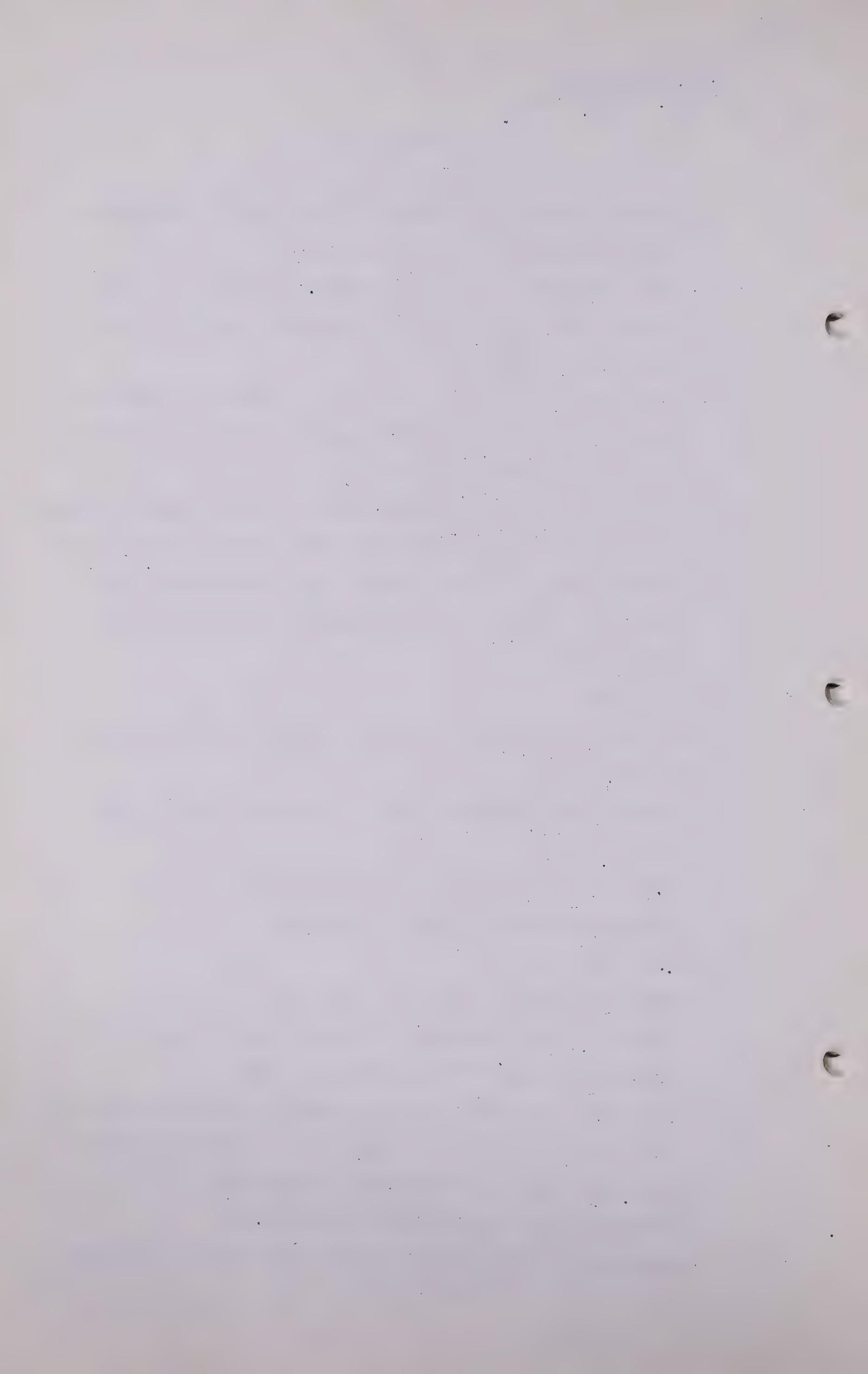
A I think it is perforated. I am not sure whether it is a shut-in gas well or potential gas well.

Q All right. And north of that 4 miles there is a dry hole?

A Well, there is a very old well. No, I won't say that I know its age. We have little data on it.

Q You do not know whether it is a dry hole?

A We have a dry hole symbol but we could not put anything



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concrete on it.

Q And your boundary there is about half way between the gas well and the dry hole?

A Yes, sir.

Q And then west of this gas well that we are talking about there is another dry hole?

A That well had very poor sand development, that is true.

Q You won't admit it is a dry hole?

A I do not like the term "dry hole" because too often what have been called dry holes are mechanical problems or economic problems which have no bearing on the gas reservoir.

Q Would you call it an absolutely non-commercial well?

A I think I would call that an absolutely non-commercial well.

Q I see. Then perhaps to save me using that term you can understand me to mean that when I talk about dry holes?

A Yes, sir.

Q That is right. Now then, your boundary with regard to this dry hole, your boundary seems to be about  $3\frac{1}{2}$  miles from the gas well and  $1\frac{1}{2}$  miles from the dry hole?

A Yes, sir.

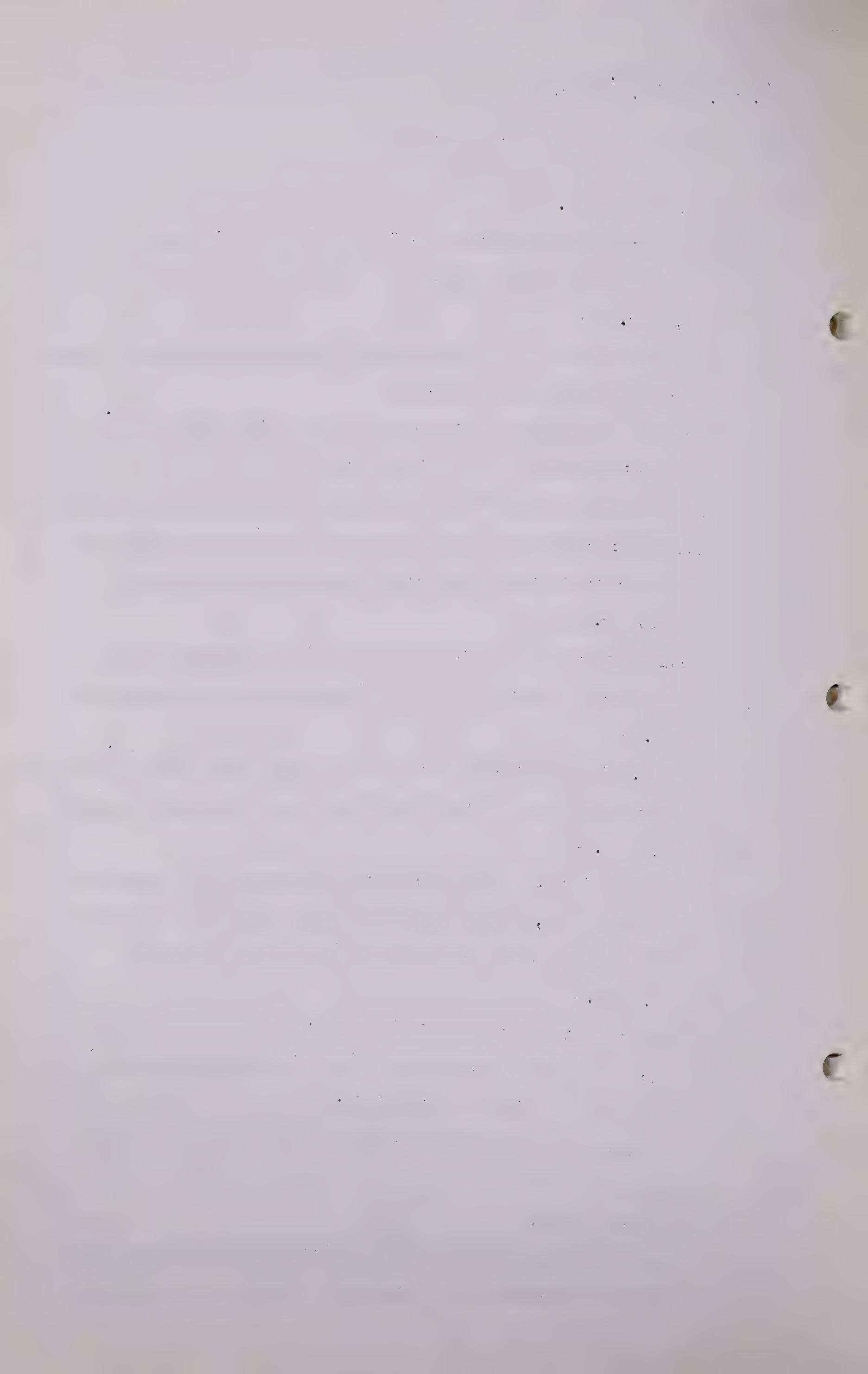
Q And you gave us a reason for that, did you, or will you?

A No, the limits drawn with a wide scattering of wells, they are essentially arbitrary.

Q I wonder why you did not make it half way the way you did up above?

A I don't know.

Q I would suggest to you that perhaps it would have been better judgment to do that even assuming the accuracy



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or otherwise of your delineation?

A It might have, although I am not prone to take purely mechanical divisions on reservoir limits because unfortunately they do not perform that way.

Q Now, will you look at the well in 12-50-13, in Township 50?

A 13, yes, sir.

Q Section 12, Range 13?

A Yes, sir.

Q You have pointed out to us that that well with 2 feet of sand, your line passes very close to it on three sides?

A Yes, sir.

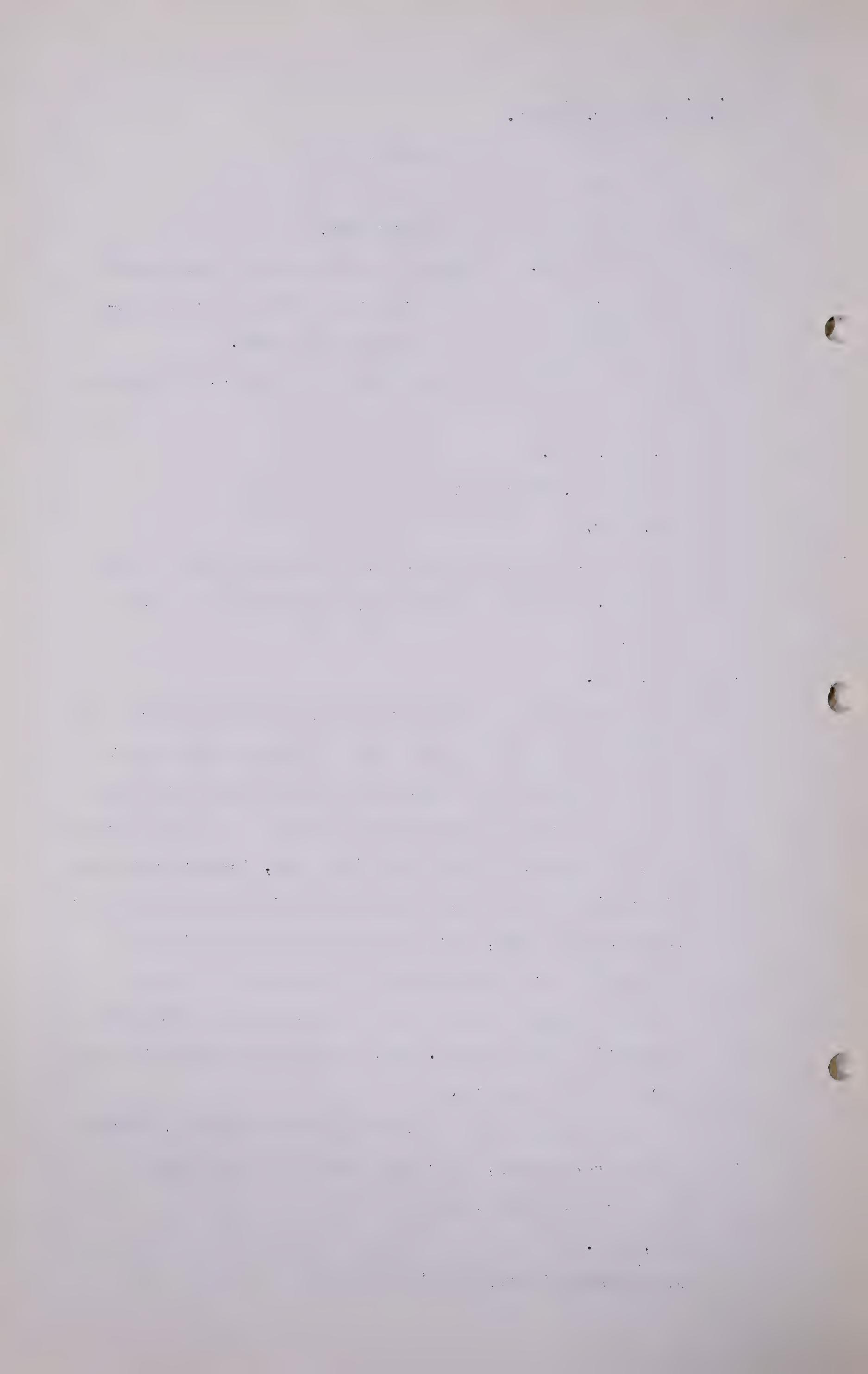
Q Would you think it would have been better to place that line further from the dry hole by a couple of miles?

A No. Our idea of the limits here that we were trying to attempt to compute reserves on centred around a thickness of approximately 2 feet as being, say, taking into consideration the dominant proportion of the gas reservoirs, 95 or 98 per cent, and the poor scattering of wells outside of that included the other areas of lesser thickness in purely the possible categories since the saturation was limited. No, I am not unhappy with the location of that one.

Q Then from this well we have been talking about, Texas-Superior-Ranfurly, your line runs west by north a distance of about 7 miles?

A Yes, sir.

Q And then southerly about 3 miles?



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A That is correct.

Q And southeasterly about 9 miles before it comes within 2 miles of the gas well, is that right?

A That is correct, although that well No. 10 lies within about 2 miles of the gas well in Township 49, Range 13.

Q The only well drilled in this area in the past 5 years is that in Section 29, Township 50, Range 12?

A Township 49, Range 12.

Q No, Section 29, Township 50, Range 12, that is, Texas-Superior-Ranfurly No. 4?

A That is correct.

Q In all that large area?

A That is right.

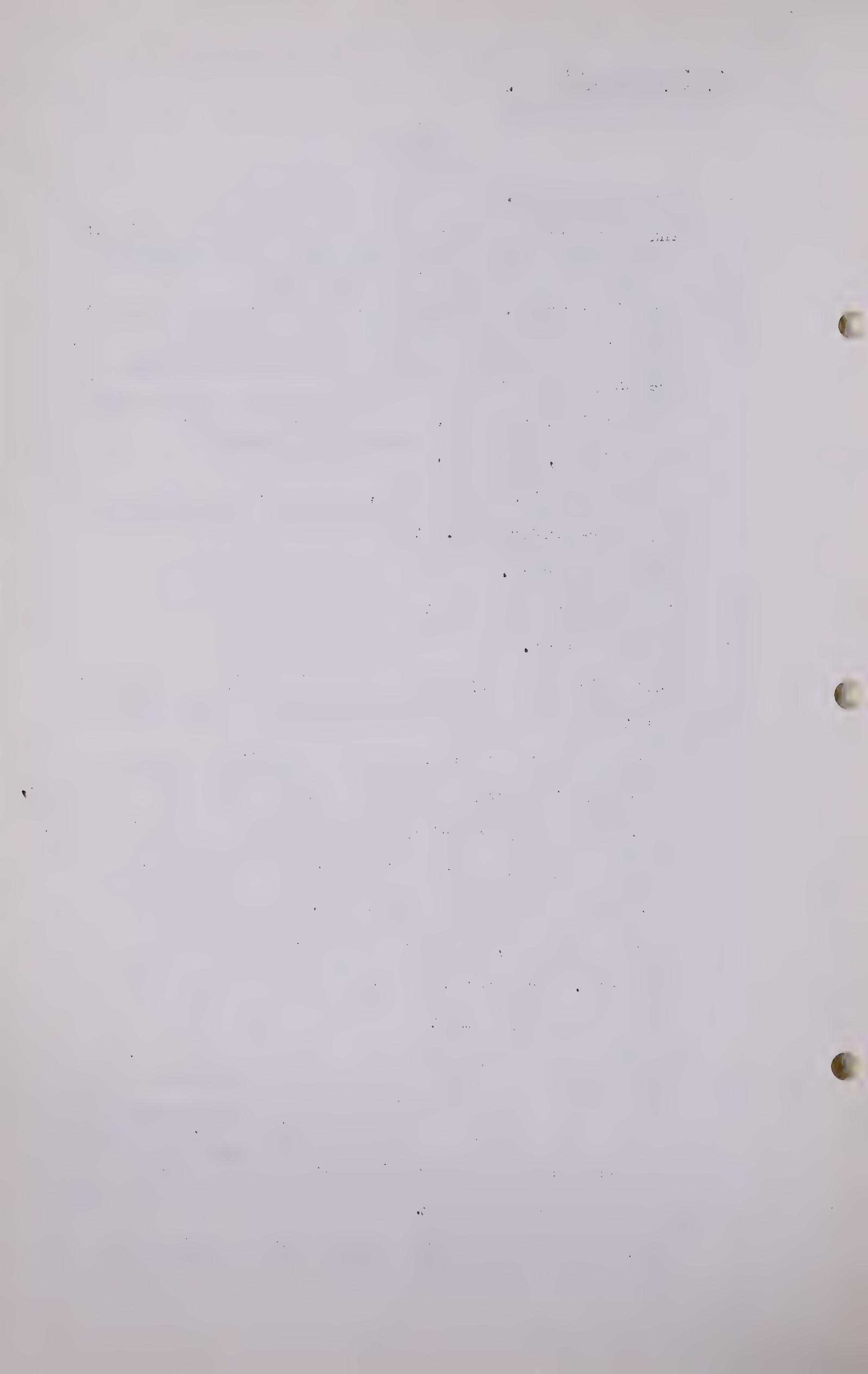
Q That well was a dry hole or an absolutely non-commercial well?

A I do not think you could make a commercial completion there but it certainly had gas saturation in the reservoir, which is what I am primarily interested in in this study.

Q Is there any sound basis in your opinion for including such an area as proven if in that area you have got one commercial well, another well which tested on completion 1350 Mcf. through a peto tube after one hour's blow and a number of dry holes? . . . . .

A I would say the pressure evidence is irrefutable. The pressure on that well dropped without production, then it has got a drainage from the Viking area. If you did not take it into account in your computations, your computations are in error.

Q Now, we are talking about quite a large area here and



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I would like to ask you whether you would advise the drilling of wells in that area, one well to every two or three sections?

A We had projected in our availability studies wells in Township 49, Range 12, in the north half of the township, and some wells in Township 50, Range 12, as a combination development program in forecasting the future availability. We chose a wide spacing because the evidence of Well No. 10 would indicate that you can fairly effectively drain those thin sands at long distance, because on the average the Viking had a high permeability for shallow sand reservoirs, considering its thinness. So I am not worried about the drilling of the wells for the drainage of that area by the pressure sinks around Viking. That would depend on the availability program in the future, whether you needed more capacity.

Q You understand, of course, that Northwestern's problem over the next years is to meet peaks?

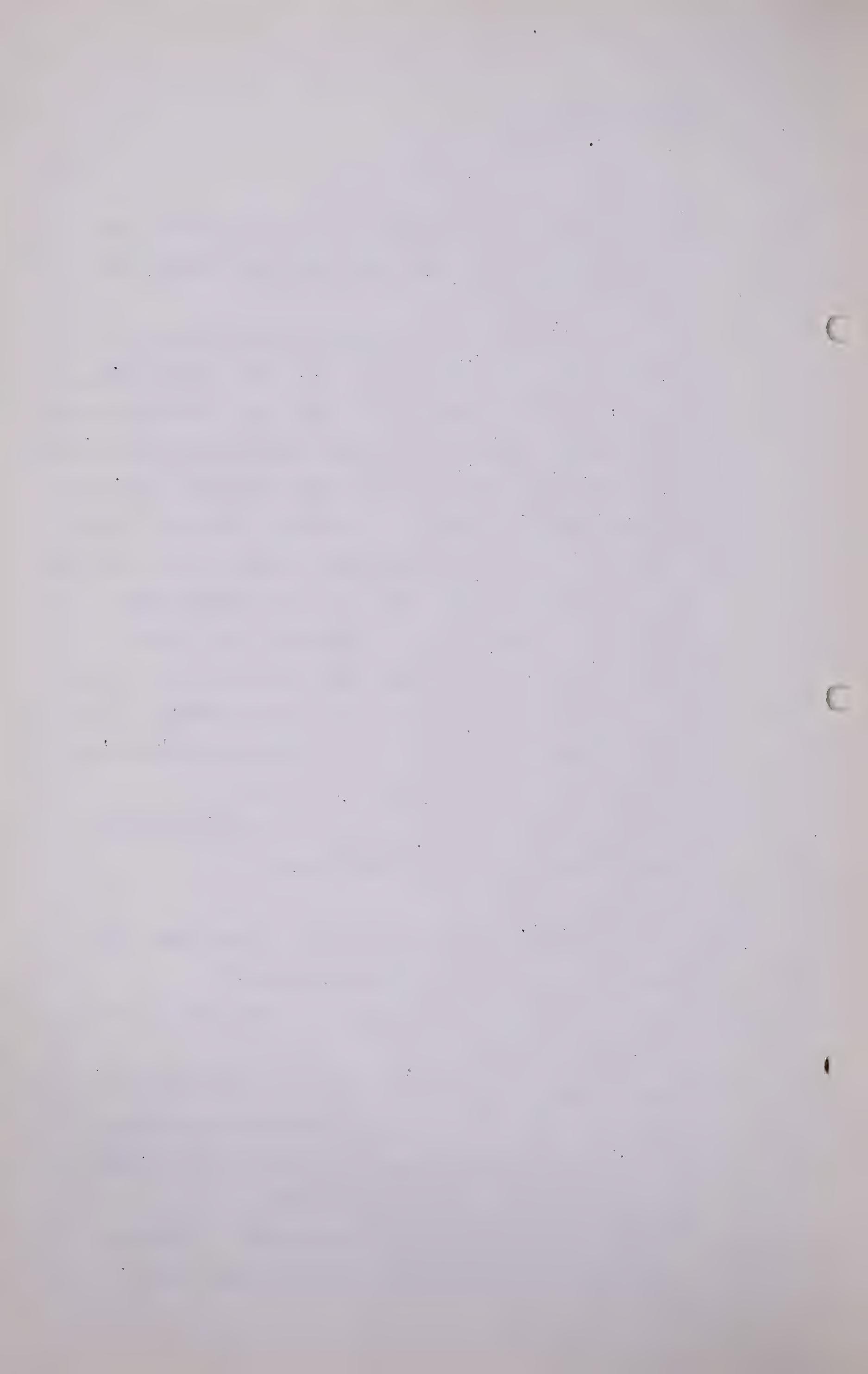
A That is correct.

Q And you understand that in order to do that this field has to be developed to its full capacity?

A Well, I would make that assumption, within the limits of economics at the time.

Q Are you suggesting that in order to get Northwestern's production daily up to the highest figure possible it would be an economical thing to drill this area, this particular area we are referring to?

A I do not think it would be an essential. I think it could be drained very well by the pressure sinks.



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Q I am asking you, would it be economical to drill new wells in this area for the purpose of increasing the daily production of the Northwestern system?

A That would depend on when you would want to do that and what the economics would be at that time.

Q Well, we are told it will be difficult for Northwestern to meet its peaks, I think some time in 1958, 1960, and we are also told that this field has got to be completely developed, and what I would like you to tell me is how you are going to advise the complete development of the field. Are you going to drill wells all through this outside area or are you going to allow the outside area to be drained by wells drilled in the central part?

A It would be a combination of the two. In other words, I would drill a sufficient number of wells, perhaps 6 or 8 scattered wells, out through there to see what the completed permeability of the sands turned out to be and what the well capacities were. If sufficiently sized wells were developed, that would be fine. If not, then I would say let us drain it by the pressure depletion within the developed area.

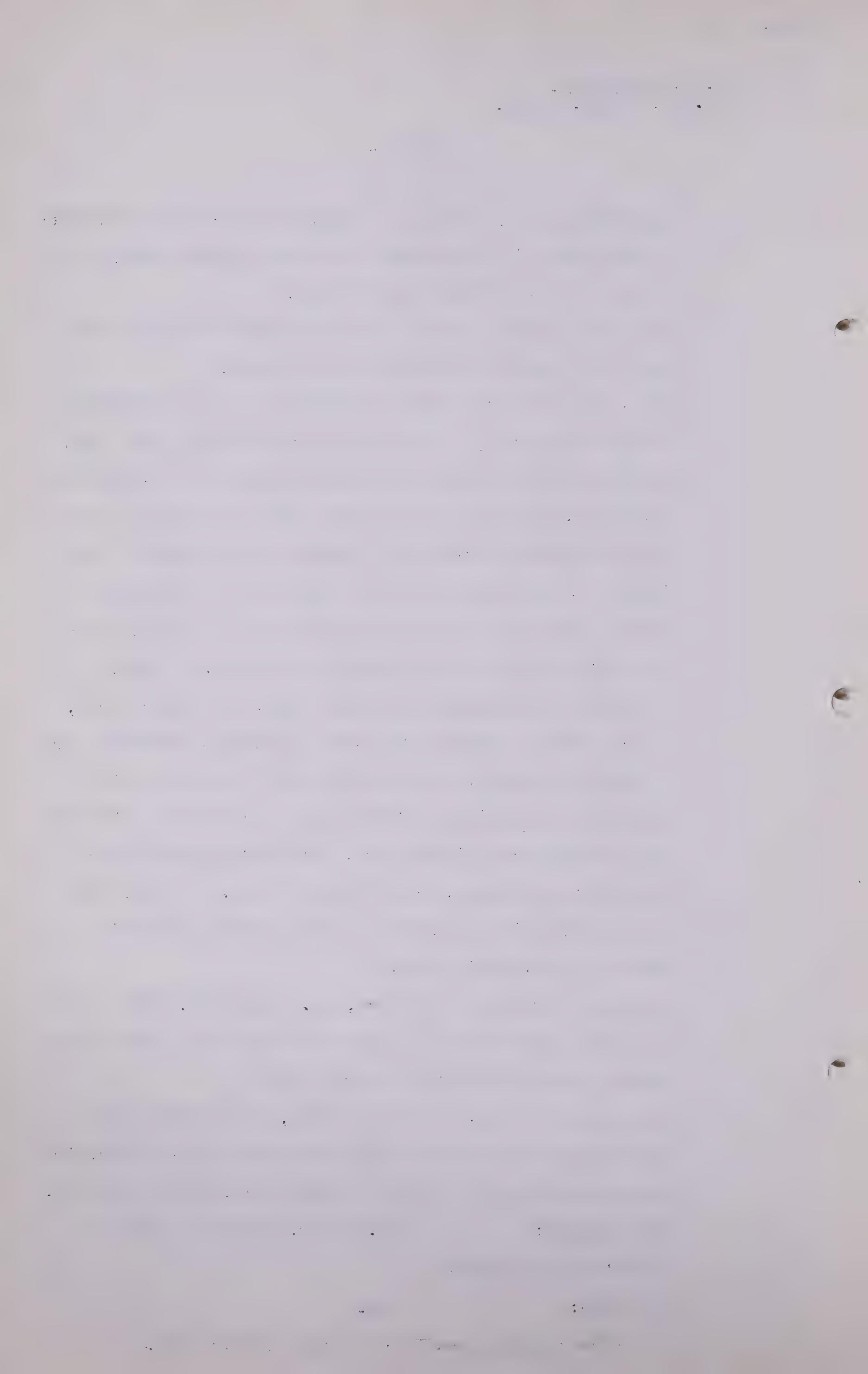
Q I gathered from your evidence, Mr. Dougherty, that if we did drill wells in this outside area we would simply be taking gas away from the central area?

A That would be true. In other words, by drilling this you increase the rate at which you exhaust the reservoir and has nothing to do with ultimate recovery necessarily.

THE CHAIRMAN: Mr. Steer, would you like to adjourn at this time?

MR. STEER: Yes.

(The Hearing then took a short adjournment.)



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Q MR. STEER: We were talking, Mr. Dougherty, about the possibility of drilling in Township, the northern part of Township 49, Range 12; in Township 50, Range 12 and 11, and the Northern part of Township 49 in Range 13?

A Yes, sir.

Q If wells were drilled in those areas it would be necessary to lay 4-inch and 6-inch pipe?

A Depending on the size of the well, I would make the assumption.

Q And the cost of that would be \$8000.00 a mile for 4-inch pipe and \$12,000.00 a mile for 6-inch pipe?

A I will take your figures on it. I have no figure in mind.

Q And that would mean in this area which, admittedly - I think you admit, do you not, that the sands are thin?

A Our work would indicate between 2 and 10 feet in thickness.

Q Then you would get very expensive production?

A Well, I do not know as to that, that would be an operating problem depending on your situation.

Q Yes?

A In any event, you cannot drill a commercial well?

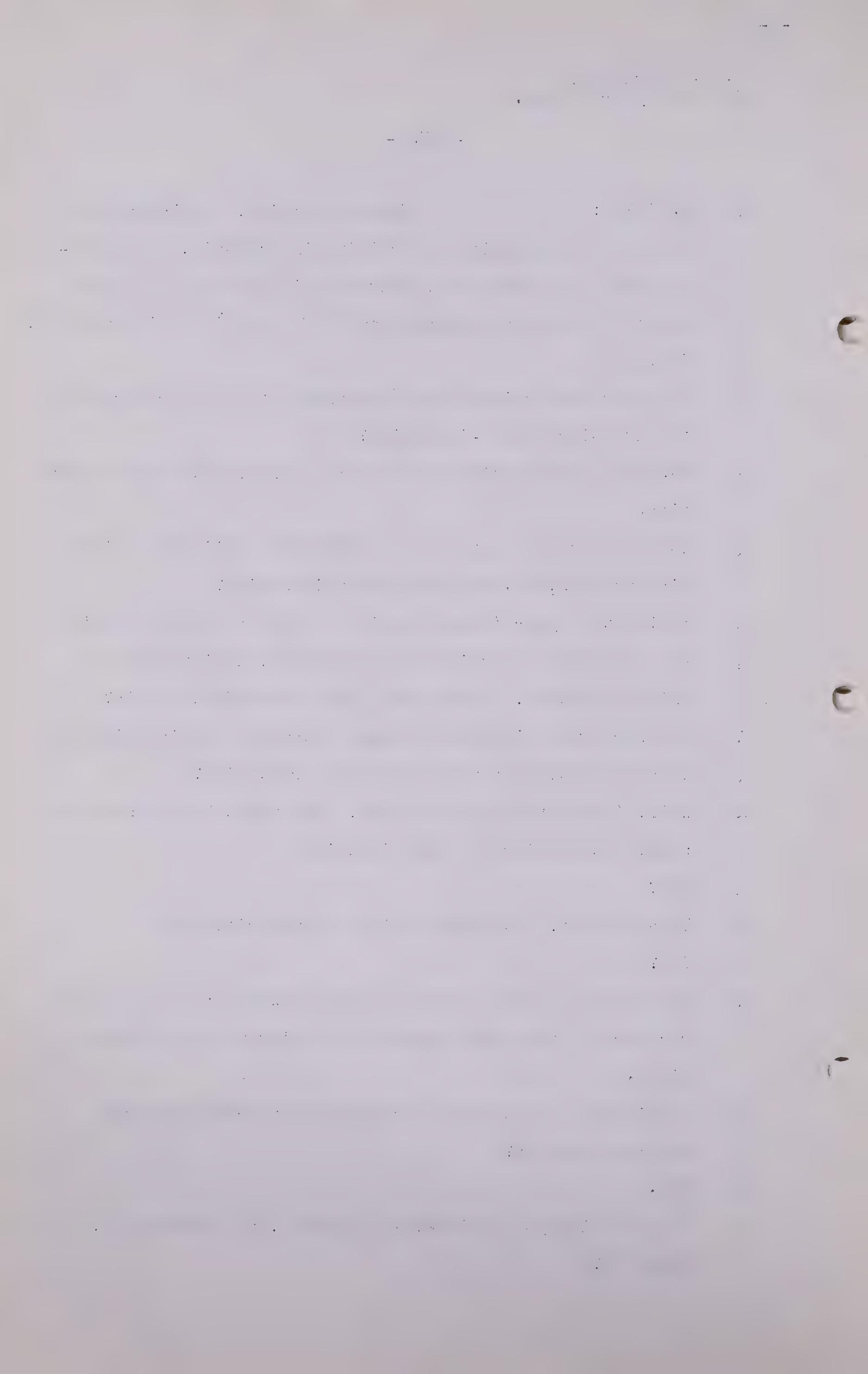
Q Yes?

A The pressure would indicate that you would have commercial recovery of that gas through the Viking and the Kinsella field.

Q I think you would have to discuss it as an operating problem later on?

A Yes.

Q I would like you to look, if you will, at Township 50, Range 12?



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A Yes, sir.

Q And I suggest to you that you classify there as proven about 32 square miles?

A I think that is right.

Q And that in the proven area you have a gas well and two dry holes, giving our interpretation with regard to dry holes?

A A dry hole with 500,000 cubic feet, yes, sir. I would always want to make that qualification, if I may.

Q Well, you will say then that we have one gas well and two holes, producing one of them, producing small quantities of gas - I am sorry, you would have one one gas and two holes producing, one of them producing small quantities of gas, but both basically non-commercial?

A I would say the likelihood of their being commercial at this time is limited, but there is gas saturation in the sand which can be recovered by drainage.

Q MR. PORTER: Recovered?

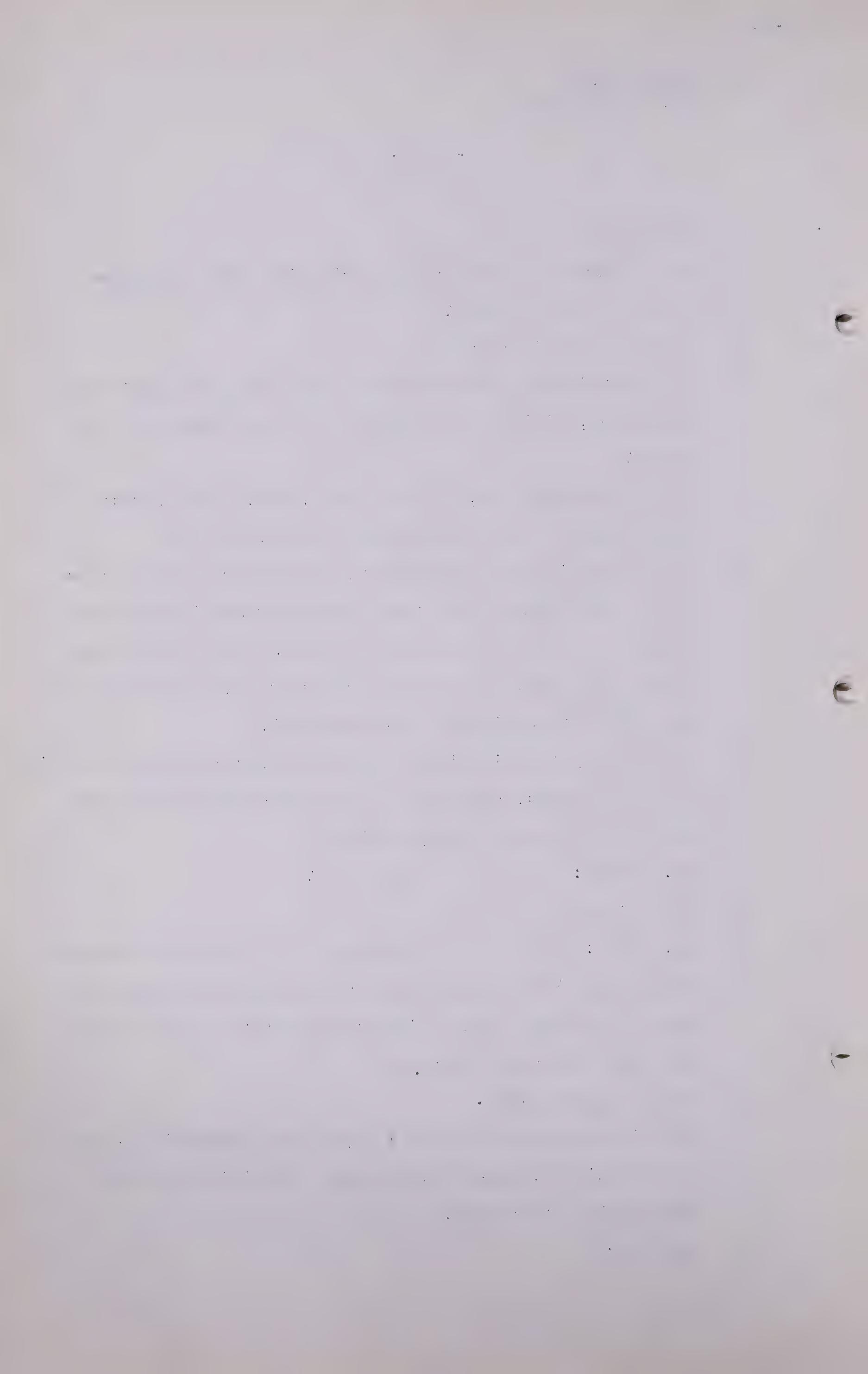
A By drainage.

Q MR. STEER: My suggestion to you is that what should have been included as proven would be an area of about one or two square miles around that gas well, and you would not agree with that?

A That is quite right.

Q Then in Township 50, Range 14, you have classified - no, in Township 50, Range 13, you have classified about 17 square miles as proven?

A Yes, sir.



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Q And in that area there are two dry holes? I hope I do not have to expand on it each time.

A No, sir.

Q There are two dry holes and no gas wells, would that be right?

A Yes, that is right.

Q In Township 50, Range 14, you have 7 square miles proven, although no tests have been drilled in the township at all?

A Correct.

Q That is right?

A Yes.

Q And to this area the nearest well is, including a dry hole,  $2\frac{1}{2}$  miles to the east?

A I think that is correct.

Q And a very small, non-commercial well about 2 miles south-east of the south east corner of the township?

A That is correct. I would like to point out, however, on page 6 that a reasonable extrapolation of the pressure contours would indicate that there is considerable likelihood for a very substantial portion, as a very substantial part of that area is already under drainage, in view of the performance and the pressures on Well No. 10.

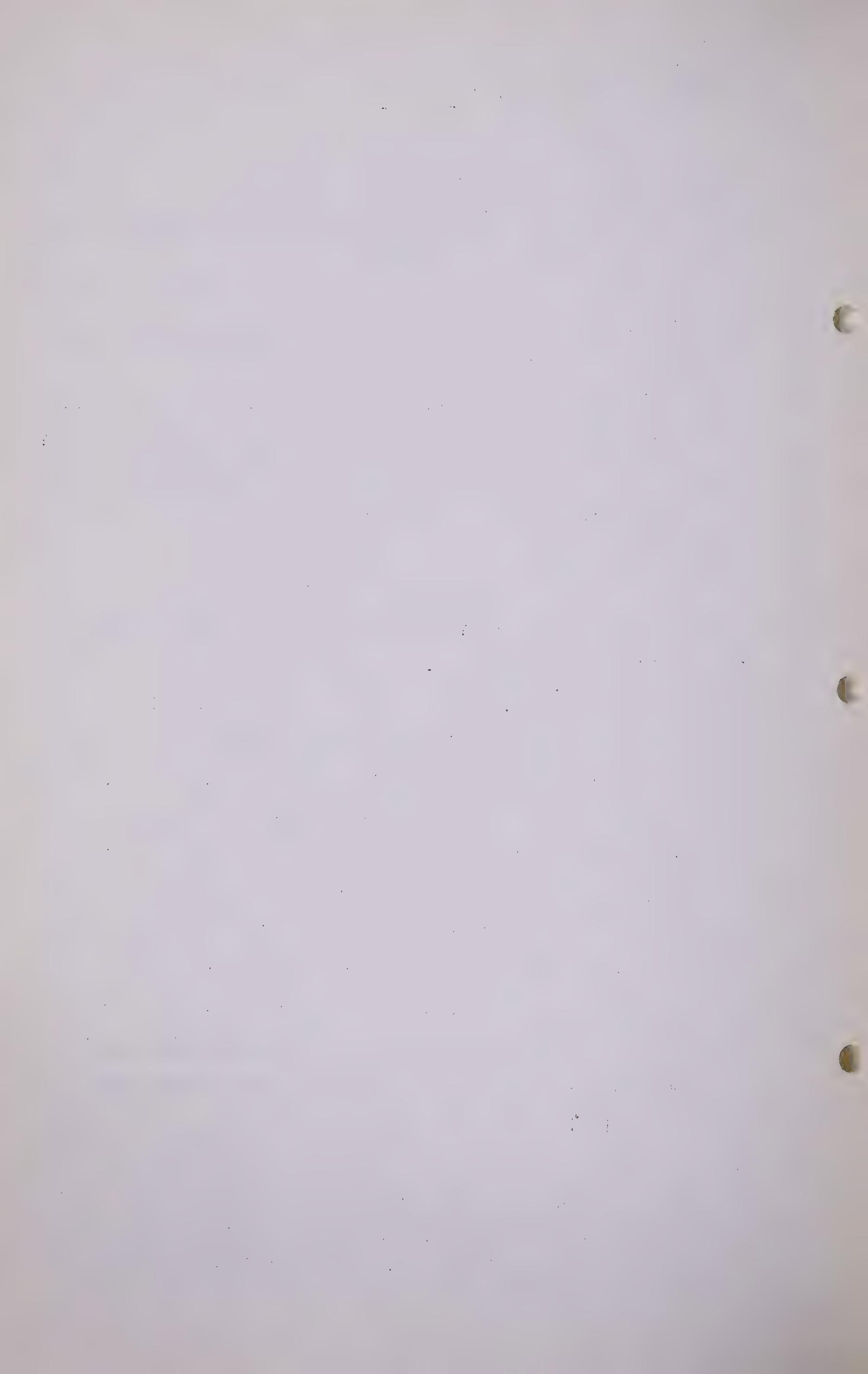
Q Now, dealing with this question of drainage, is it your idea that these wells drain from the very outside edge?

A Eventually.

Q Eventually?

A Yes.

Q But so far as this question of pressure drop is concerned that you have spoken of, no, pressure build-up that you



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have spoken of. . .

A Pressure build-up from the pressure area out to the other area.

Q Yes?

A Yes, sir.

Q And is your suggestion that that takes place, the drainage from adjacent areas or from the outside areas?

A Well, from all the intervening area out to the limit which would be indicated by the extrapolation of those pressure contours.

Q My suggestion to you is that pressure build-up takes place as a result of drainage from the near-by areas and not the outside areas at all?

A No. In view of the pressure on No. 10 some place to the north west of No. 10, we would eventually come to the original reservoir pressure, and the only control we have is the indicated gradient.

Q Now, you did not get the original virgin pressure when No. 10 was drilled, did you?

A No, sir, that was drilled in 1946.

Q Yes?

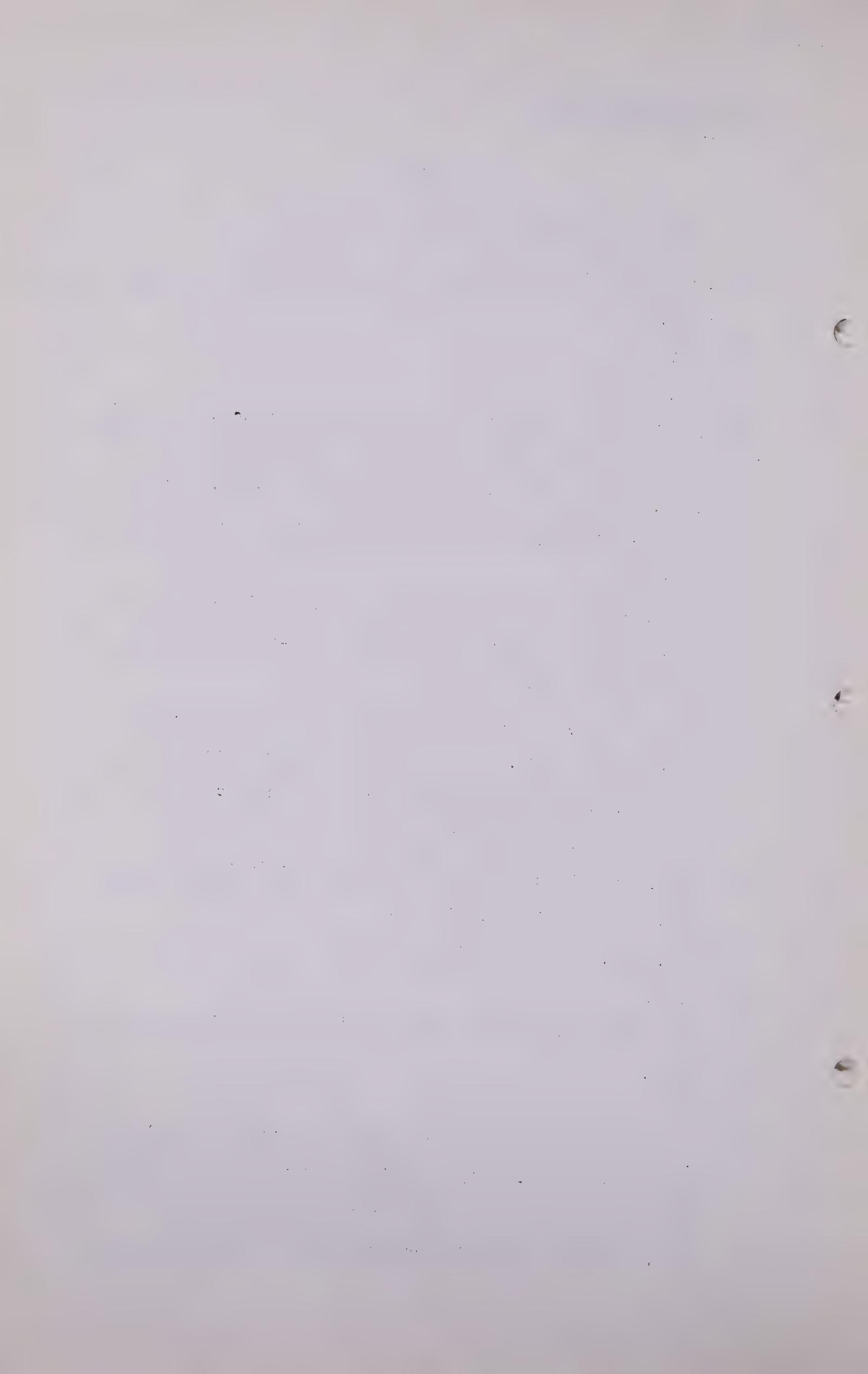
A And Viking proper had been produced since prior to 1918.

Q Yes?

A With quite a lot of gas.

Q And does not that indicate that the pressure drop, the pressure build-up in the Viking area was due to drainage from such wells as the Imperial Kinsella No. 10?

A No. 10 and all the intervening area and the area outside



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of that.

Q Yes?

A Yes, sir.

Q Now, I would like you to look at these fixtures, if you will (indicating)?

A Yes, sir. Who is the witness on this exhibit?

Q I beg your pardon?

A Who is the witness on this exhibit.

Q Well, I will give you some assumptions, Mr. Dougherty, which you are quite capable of making?

A All right.

MR. STEER: Will this be Exhibit 12, sir?

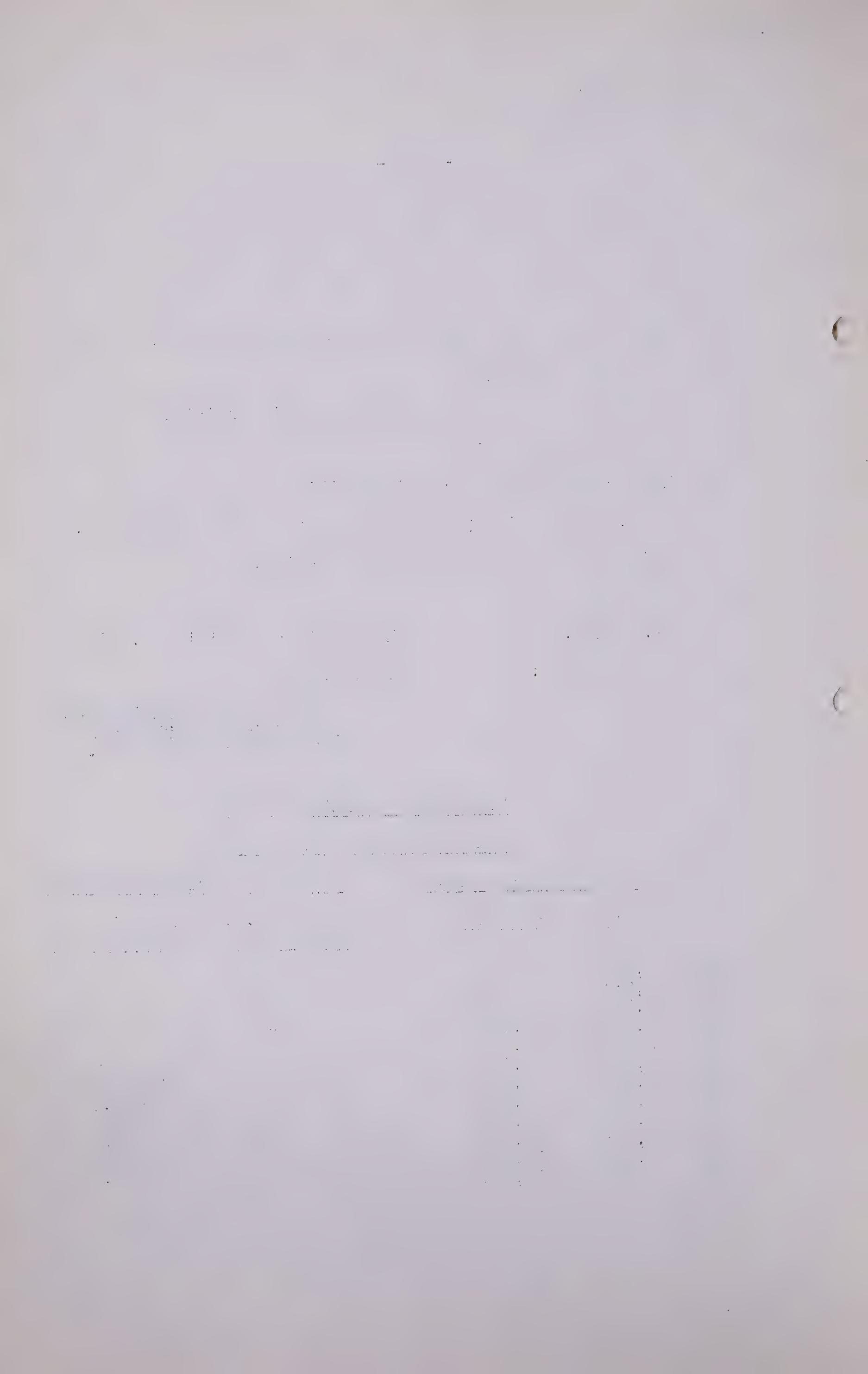
THE CHAIRMAN: Yes, Exhibit 12.

VIKING AND KINSELLA FIELDS  
PRODUCTION AND PRESSURE  
DATA MARKED EXHIBIT 12.

VIKING AND KINSELLA FIELDS

PRODUCTION AND PRESSURE DATA

	Production MMCF		Well head gauge pressures		
	Viking	Kinsella	Average C.P. Viking Wells	Imp. Kin. #10 Press.	
1939	3,670	0	518		
1940	4,081	326	504		
1941	3,775	943	485		
1942	1,855	3,523	-		
1943	2,182	4,573	493		
1944	2,410	5,175	507		
1945	2,718	6,466	494	Drilled 1946	
1946	2,835	6,256	481		609.5
1947	2,016	8,793	483		601.0
1948	2,268	10,706	488		595.5
1949	1,285	13,589	481		590.5
1950	149	18,831	501		585.0



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MR. STEER: I have got to find my assumptions.

Q Now, you point out from 1945 to 1950 there was a pressure build-up of 520 pounds per square inch to 540 pounds per square inch. Your statement was this:

"We have had five years' production and yet the pressure of the Viking-Kinsella in that part of the field in 1950, in part of the field at least, is 20 pounds higher than it was 5 years back. That indicates to us that these marginal areas, so-called, are making a substantial contribution to" - I take it it should be instead of "of" - "the upholding of the pressure picture and that we are not ready to write off any part of a gas reservoir so long as there is gas saturation in some measurable quantity in making our reserve estimate."

Now, these figures which I will undertake to prove, indicate that the average arithmetical well pressure of wells in the Viking-Kinsella area was 481 pounds in 1949 and 501 pounds in 1950. Do you follow that? That is in the 4th column.

A 494 to 501?

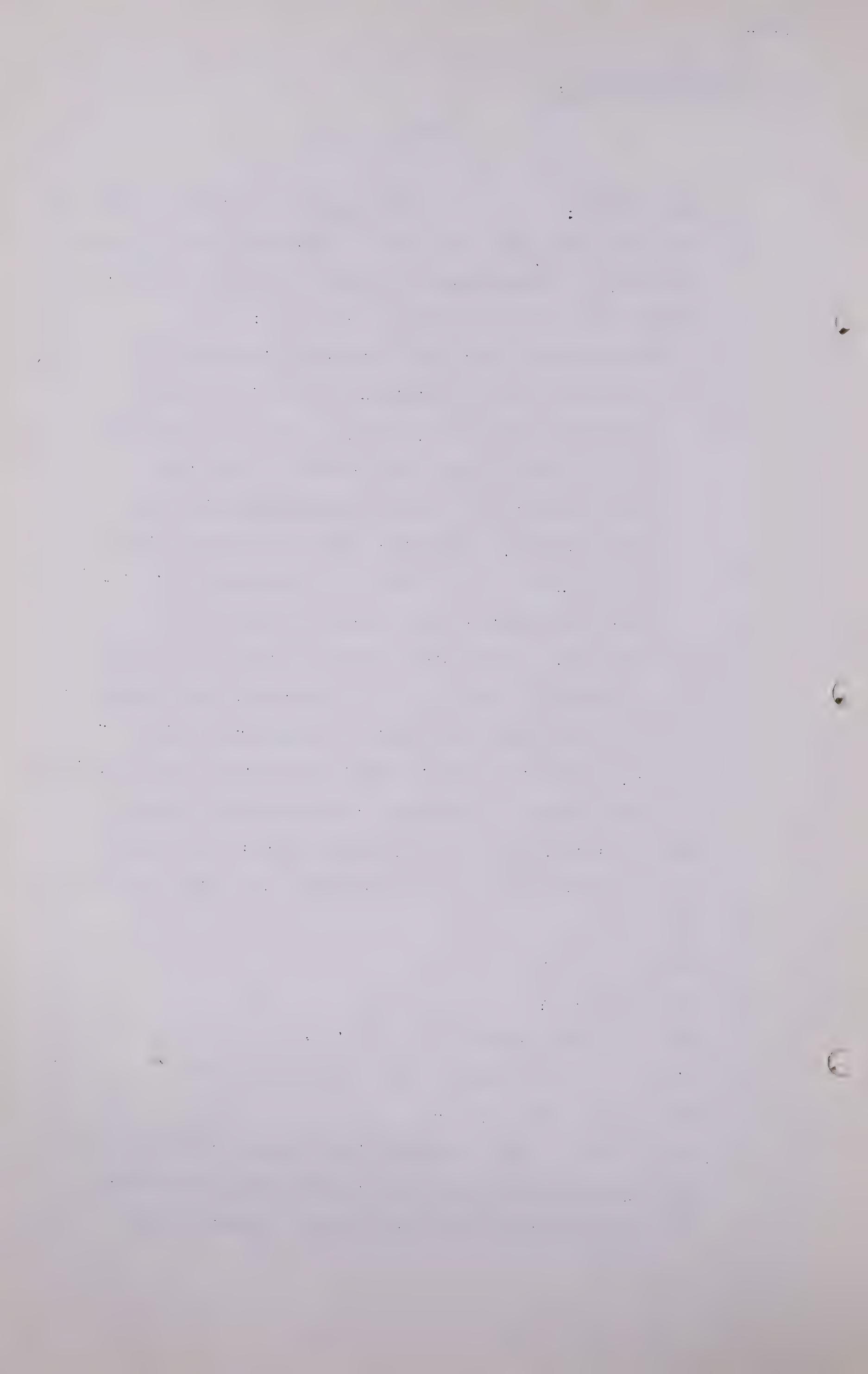
Q 481 to 501?

A Yes. The other would be in '46.

Q '49 to '50 is the figure, the last two figures.

A Oh, I see. Yes, sir.

Q Yes. Prior to 1949, assuming this is correct, prior to 1949 gas withdrawals from these wells were in excess of 2 billion feet per year. In 1949 it dropped to 1285



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million cubic feet per year. In 1950 it dropped to 149 million. I am asking you whether this sharp reduction in gas withdrawals during 1949, and again in 1950, would not cause an equalization of pressure from the area within your proven area immediately surrounding the low pressure area with which we have been dealing?

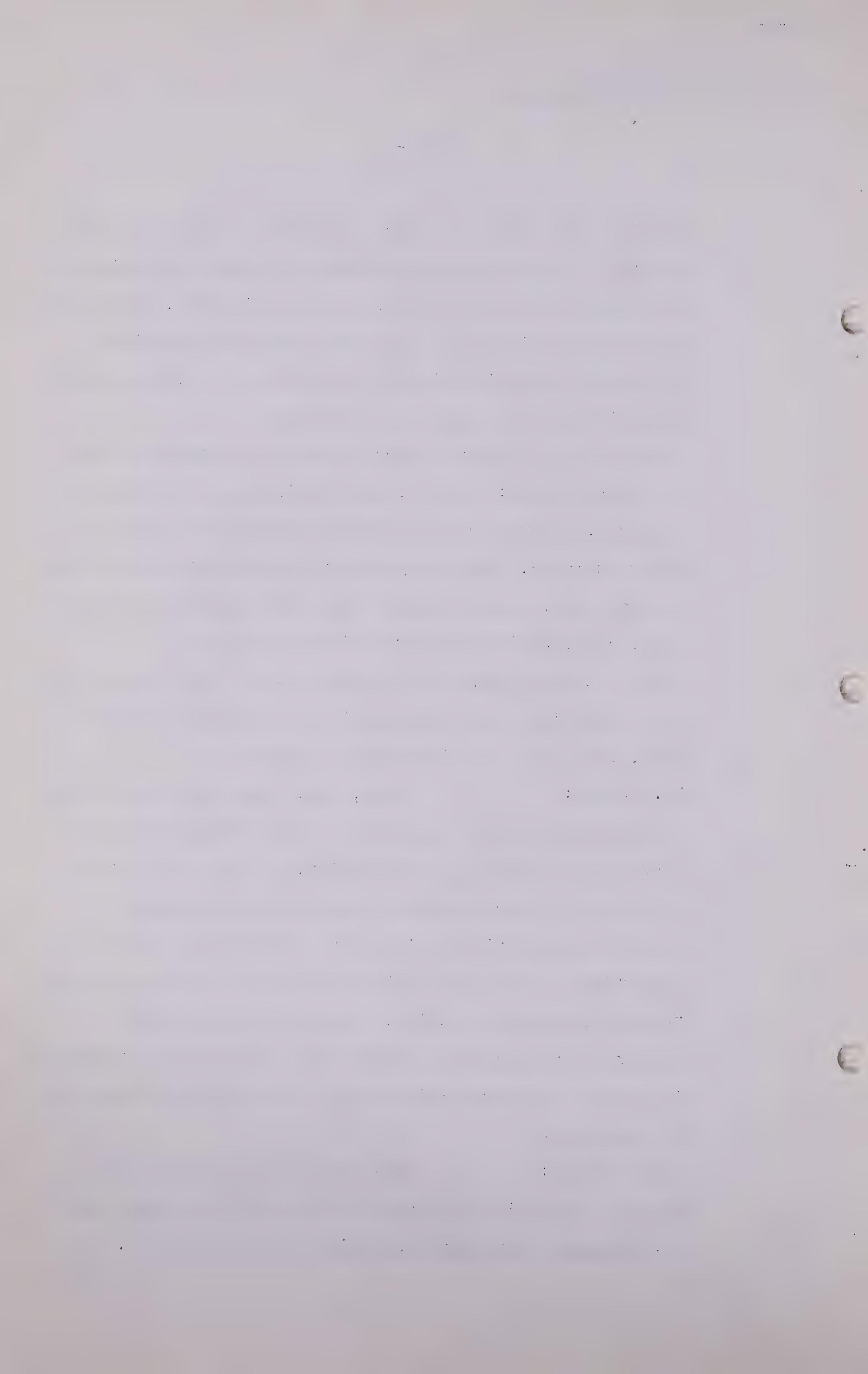
A I think there are two errors in these computations that are fairly basic; that is, the utilization of arithmetic averages, because that is actually drawing the well as being isolated, where they have a random distribution over a large area, so that unless they are weighted in to the areal distribution the figure is meaningless.

Q I see. Assuming that that is not so, but that these figures have a meaning, would my question be sensible to you?

A Well, with those qualifications, I guess so.

MR. PORTER: Well, now, just a minute. Perhaps my learned friend might prove these things and prove what he is attempting to establish, so that this witness will have a chance to look at the finished article. I think we are getting a little far afield when the witness says "Well, that is not quite black" and the counsel says "Let us assume it is white, and go on from there." Surely we have got to establish some basis if the testimony is going to be worth while either to my learned friend or to the Board.

THE CHAIRMAN: Mr. Steer, would you like to put Mr. Davis in the stand to prove this statement and Mr. Dougherty can step down while he is doing that?



Ralph E. Davis,  
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MR. STEER: I have no objection to doing that. I intend to call Mr. Davis. I plan that he will deal with this statement when I call him, but I have no objection to Mr. Davis dealing with it now.

MR. PORTER: It is just a question of getting it in before this witness leaves here.

MR. STEER: Of course, this is the kind of thing we have been doing right along. However, if my learned friend objects we will have Mr. Dougherty stand down and I will put Mr. Davis in the box.

MR. PORTER: I see no reason for refusing to correct an error, even if it is of long standing.

THE CHAIRMAN: Perhaps if Mr. Dougherty will stand down and Mr. Davis can take the stand and prove the exhibit.

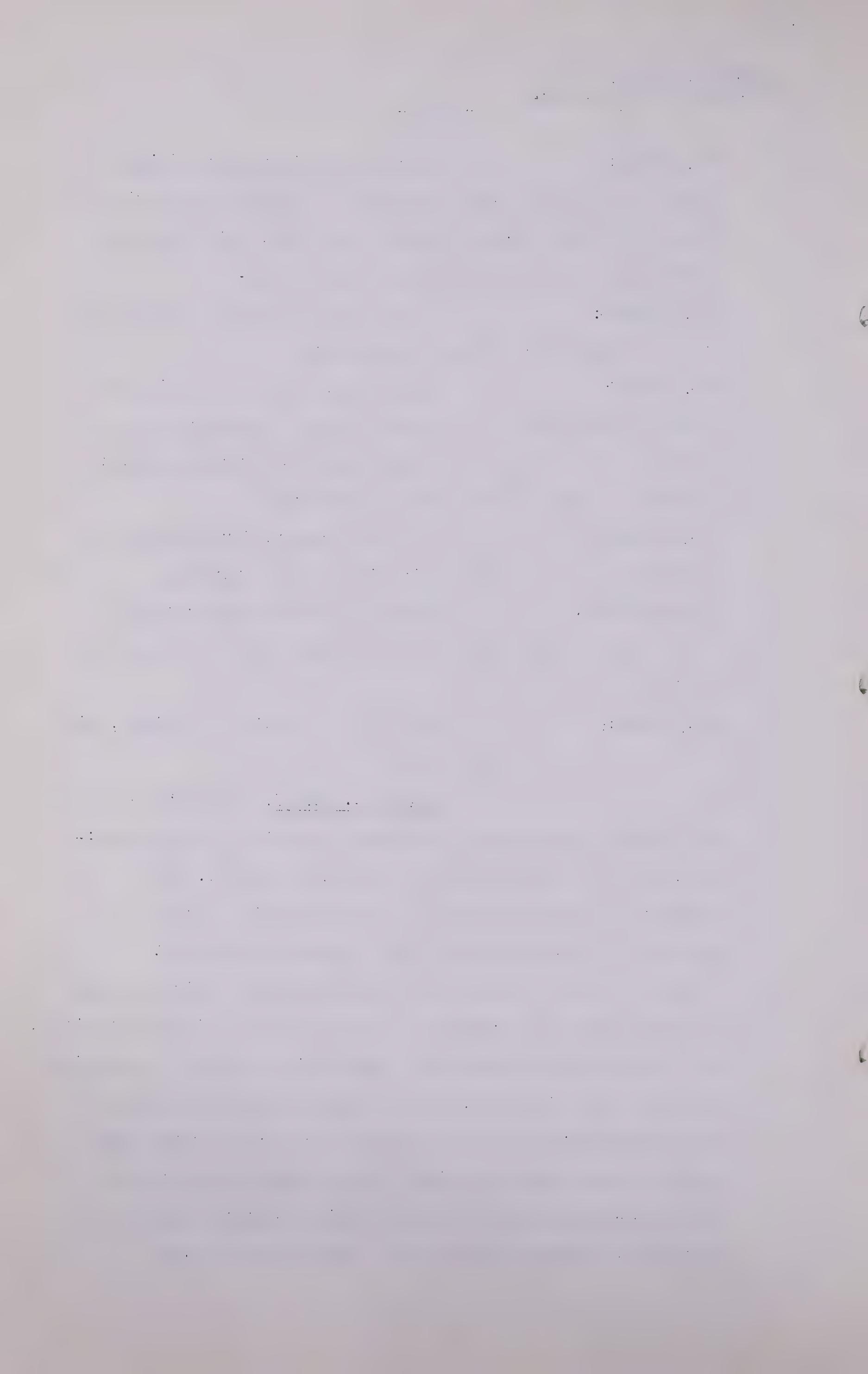
MR. STEER: Yes, that is quite all right, sir.

.....

RALPH E. DAVIS, having been first duly sworn, examined by Mr. Steer, testified as follows:-

Q Now, will you explain to the Board, Mr. Davis, this Exhibit 12 and its bearing, in your opinion, on this pressure build-up to which Mr. Dougherty referred?

A I will. First, I would like to say that the figures shown are taken from the records of Northwestern Utilities Limited, and in the second column the production measured in millions of cubic feet from the, what we call the Viking area of the Viking-Kinsella field, shown for each year from 1939 down through 1950. And just for the sake of having the total production we also show similar figures from the Kinsella portion of the field. The fourth column



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contains the figures taken also from the Northwestern Utilities Limited records and the figures, as given, are the arithmetical average of the wells in the Viking portion of the field. Now, it is true that the weighted average pressure is better than an arithmetical average, but when we are considering the drop in pressure from year to year there is not any substantial difference to be found if we take the average arithmetical figures and compare them from year to year, or if we take average weighted figures.

Q Yes?

A I would say that the figure for 1950 of 501 pounds, found by arithmetic average, may, if we were to figure the weighted average, might be a few pounds more or a few pounds less, but if that were true I am quite sure that for the previous year we would have a similar difference, and in the same direction, so that the difference in pressures from one year to the next would be approximately as shown in this Exhibit 12.

Going back to column 2, where the annual gas production of the Viking area is given, you will note that there was a year when it exceeded 4 billion feet back in 1940, that in the following year it was three and three-quarters billion, then dropped down to a rate of around 2 billion, a little over 2 billion a year for several years, getting back up to 2-8/10ths billions in 1946, and then dropping down to, in 1948, to 2 $\frac{1}{4}$  billions and finally in 1949 to about 1 $\frac{1}{4}$  billions. That is a sharp drop from 2 $\frac{1}{4}$  billion. And then in 1950 the drop was to 149 million which is a very sharp drop. I believe that the increase in the average pressure of



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the area of these wells between '49 and '50, which is of the order of 20 pounds, is due to the sharp drop in pressure, I mean sharp drop in production, which permits the gas in the near-by areas to flow in, gas from somewhat distant areas to also flow in, but at a lesser rate, and I doubt, personally, I doubt that there is any gas of any important amount coming into the area of these wells from a distance of, oh, say, 5 miles. There could be. I do not know. The fact is that there could be more than 5 miles, but I doubt if it reaches out into any distance into the, what Mr. Dougherty has called his possible area. I think it comes mainly from reasonably close-by portions of the proven area.

Now, have I identified this sufficiently to your specifications, and your satisfaction?

THE CHAIRMAN: Do you wish to ask Mr. Davis any questions, Mr. Porter?

MR. PORTER: Oh, no, I do not think I have any right to examine him at this time.

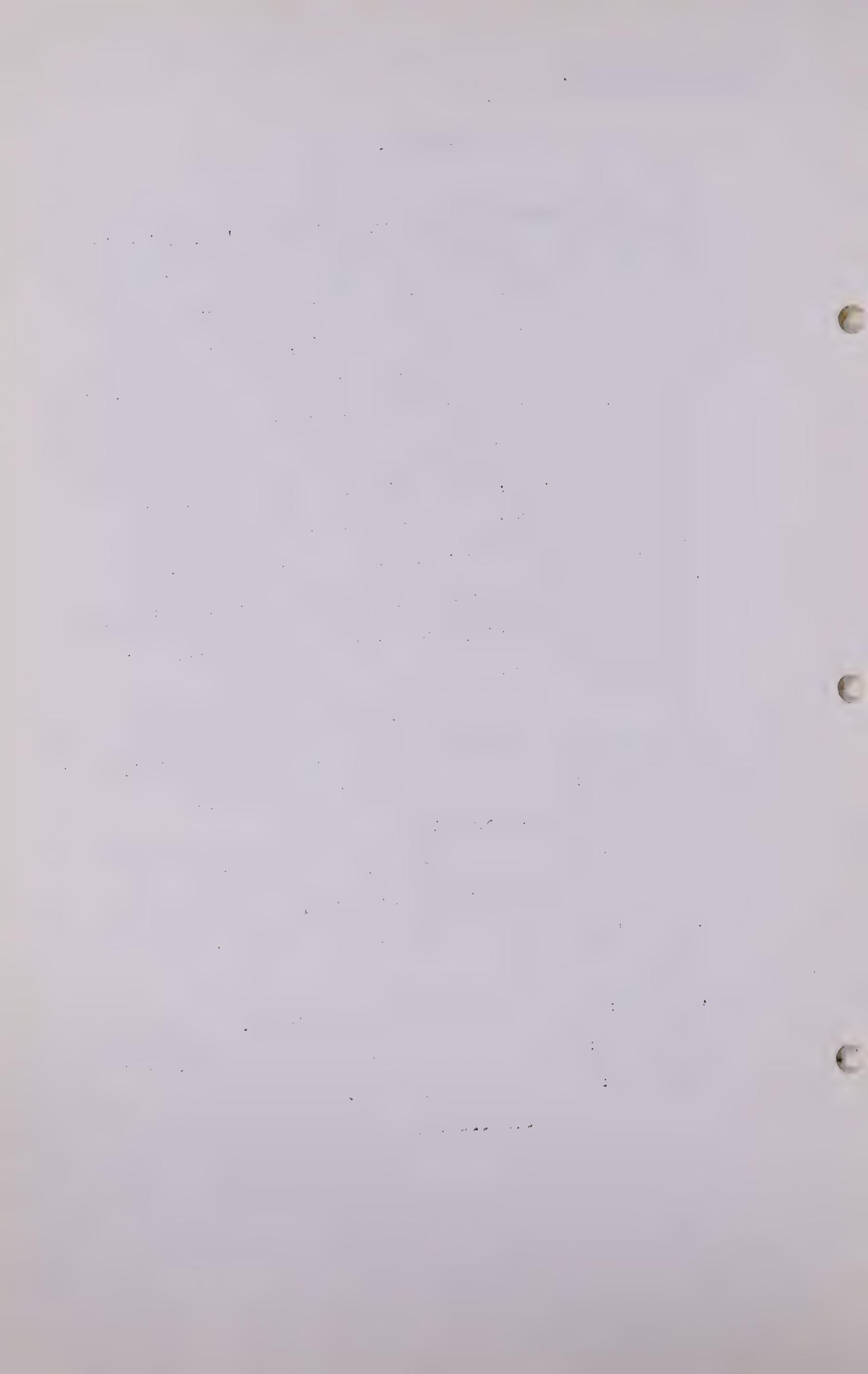
MR. STEER: You are at perfect liberty to do so.

MR. PORTER: I will do so later.

THE CHAIRMAN: All right, thank you, Mr. Davis.

THE WITNESS: Thank you.

.....



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JACK F. DOUGHERTY, recalled,

already sworn, cross-examined by Mr. Steer, testified as follows:-

Q I think I have led you away from the discussion we were having, and it is my fault. We were talking about these areas, and I pointed out to you that in 50-12 you got 32 square miles with one gas well and two dry holds, that is right?

A That is correct.

Q And in 50-13 you have 17 square miles in which there are two dry holes?

A With the usual qualifications.

Q Yes, yes. And in 50-14, you have 7 square miles without any tests at all?

A Those township boundaries are land units and we have in effect a test within a mile or two in that area, namely the No. 1 well in Township 50, Range 12.

Q I am talking about 50-14?

A Oh, I thought you were talking about 50-11, I beg your pardon.

Q No, I am talking about 50-14. I think you told us we have 7 square miles proved there with no tests?

A That is correct.

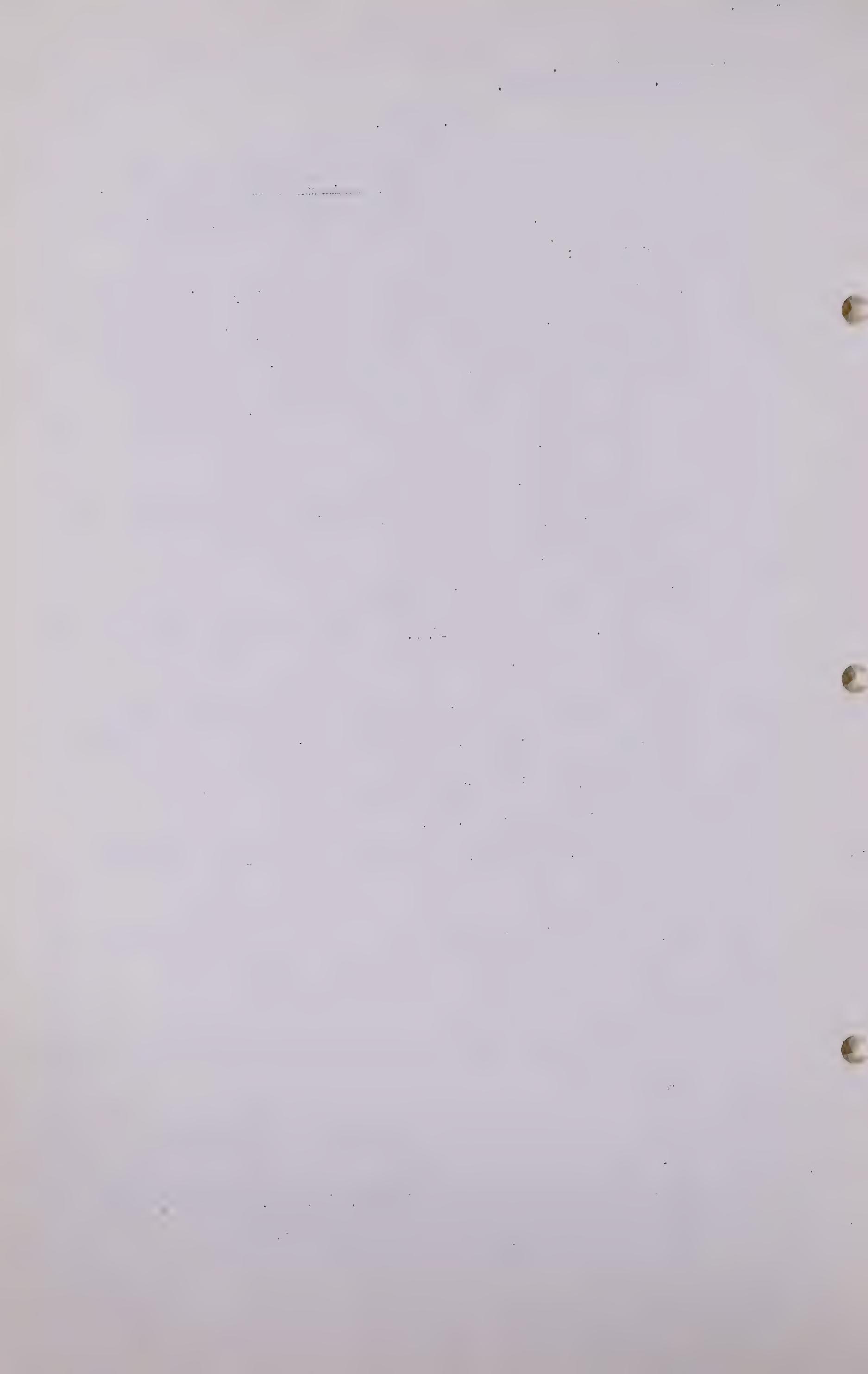
Q And in 49-13 you have 32 square miles, would that be right?

A 49-13?

Q Yes?

A Yes, sir.

Q And the only wells are Viking 9, 12, 19, 15 and 22 in the south-easterly part of the township?



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A And No. 10.

Q And this No. 10?

A Yes, sir.

Q Would you agree that No. 10 is a small commercial well?

A I would agree.

Q Pardon?

A I would agree.

Q Yes. Well, then, in 49-12, divided as it is, as you may divide it by a diagonal line, you have included both the south west half and the north east half of the boundary?

A I think that is correct.

Q Yes. And I am suggesting that the greater part of the north east half, so described, should be eliminated?

A No, sir.

Q You do not agree with that?

A That is part of the reservoir, there is no doubt about that in my estimation.

Q Well, then, in 49-11 you classify as proven 32 square miles?

A Yes, sir.

Q There is a dry hole in section 22 less than a mile from the centre of the Township, is that right?

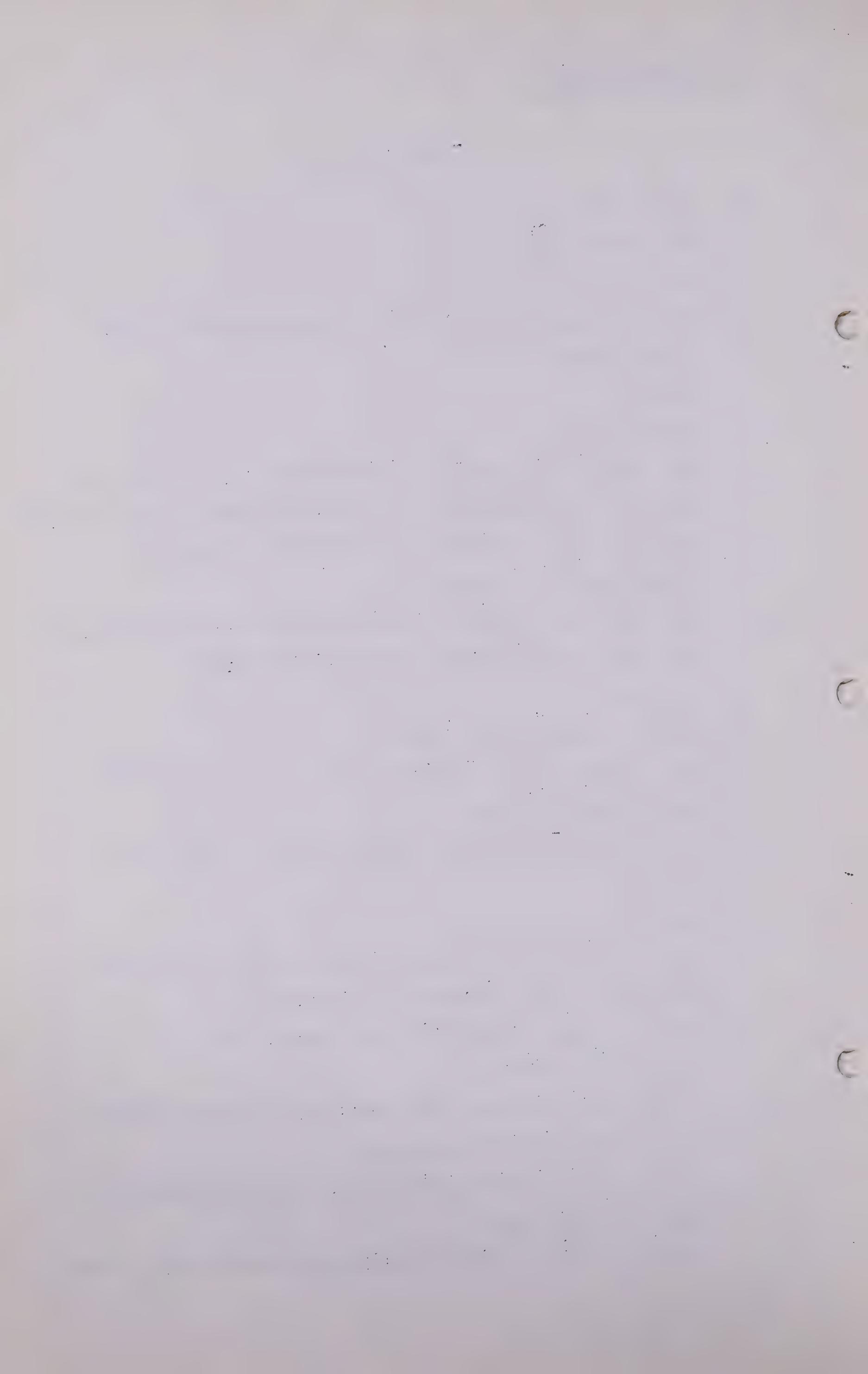
A 3 feet of sand and 490,000 cubic feet of gas.

Q Is it a commercial well?

A At the time it was drilled perhaps not; tomorrow perhaps not; 10 years from now perhaps.

Q Yes, depending upon the quantities of gas available at that time, is that right?

A Correct, but that will be commercially recoverable, I have



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no doubt.

Q Then in Township 50, Range 11, you have included 4 to 5 square miles as proven, although all you have is a dry hole in Section 24?

A Well, there is an adjacent well just across the township line, within a mile and a half.

Q All right?

A In Township 50-11. 50-12, I beg your pardon.

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Q Is this that Dominion Pete, is that the one?

A It is the well in Birch Lake.

Q That is named here Union Dominion Peak. What sort of a well is it?

A 500,000 cubic feet in 1923.

Q In 1923?

A Yes.

Q On the basis of that well do I understand you to include the whole of this township?

A No, sir. That controls and proves the gas saturation in the area of Township 50, Range 11 and Township 50, Range 12. And the Viking sand is present, developed gas bearing.

Q Now 24. The well in 24 in this Township is a dry hole.

A We have one with 2 feet of sand sufficiently developed.

Q Absolutely non-commercial I think you said at the present time?

A I agree it would be difficult to make a commercial well for production through the casing

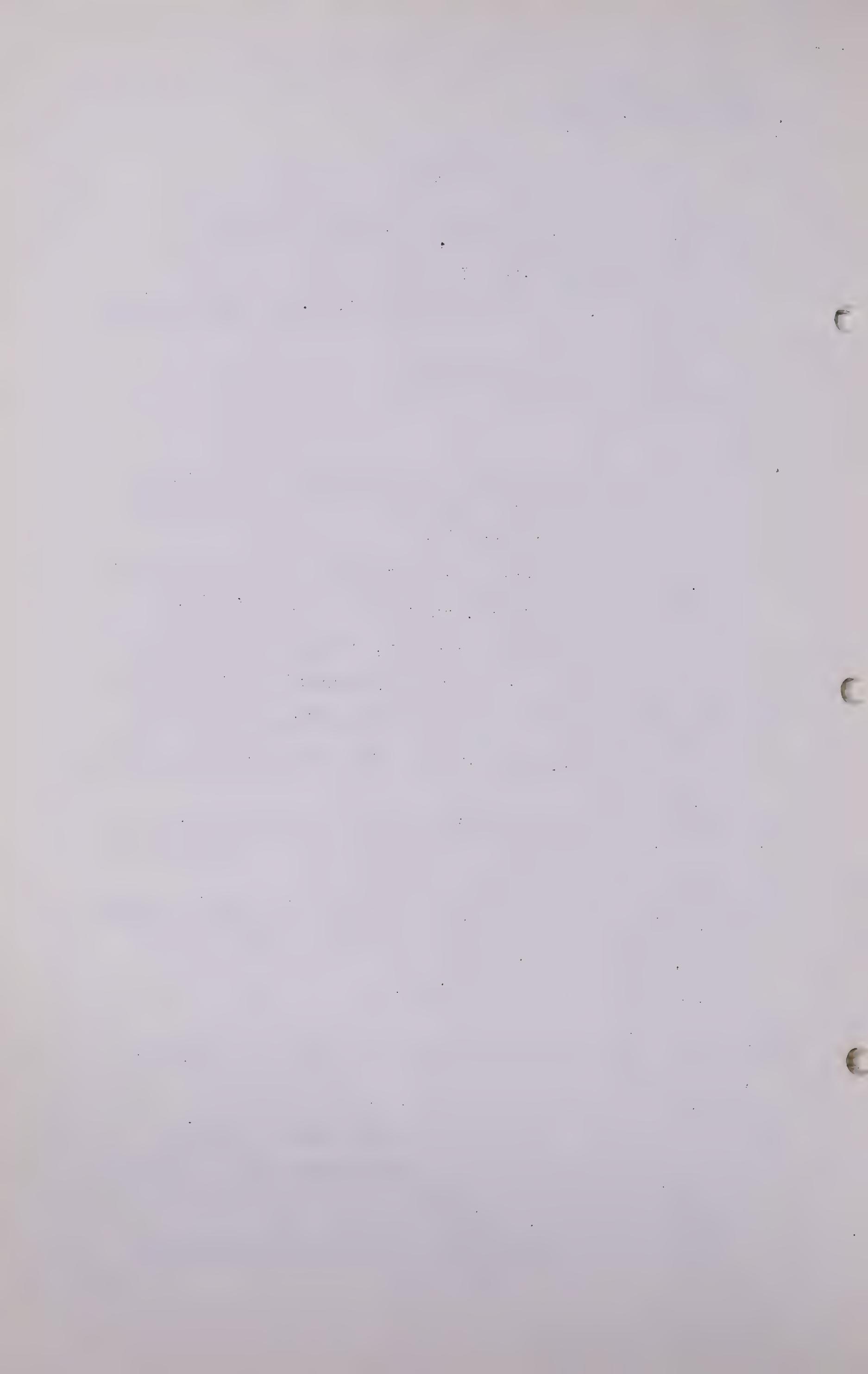
Q I think to summarize what you have said then in Township 50, Range 11, 12, 13 and 14 you have included in the proven area 60 square miles?

A Correct.

Q In an area where we have got gas wells and dry holes in a ratio of about 4 to 1?

A If you wish to isolate that area from the regional structure and the regional stratigraphy and the regional gas saturation, I will agree.

Q And whether you should do that or not is a matter of



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judgment?

A It is not as far as reservoir is concerned.

Q But you will admit it is a matter of judgment?

A It is not as far as the reservoir is concerned, but if you want to call it commercial it is.

Q In '49, ranges 11, 12 and 13 you have classified as proven 100 square miles in an area where we have 3 dry holes, 1 well rated as a commercial well and 1 well rated as sub-commercial?

A You say in 11, 12 and 13 of Township 49?

Q 49.

A No, I would not agree with that because a lot of Viking field wells are in those townships.

Q 49-13, you told us you had 32?

A Yes.

Q There are 5 thin gas wells in that?

A In 49?

Q 12.

A There are 11 gas wells.

Q Yes, but the wells in 49-13 are all in the south east corner of that township?

A Yes.

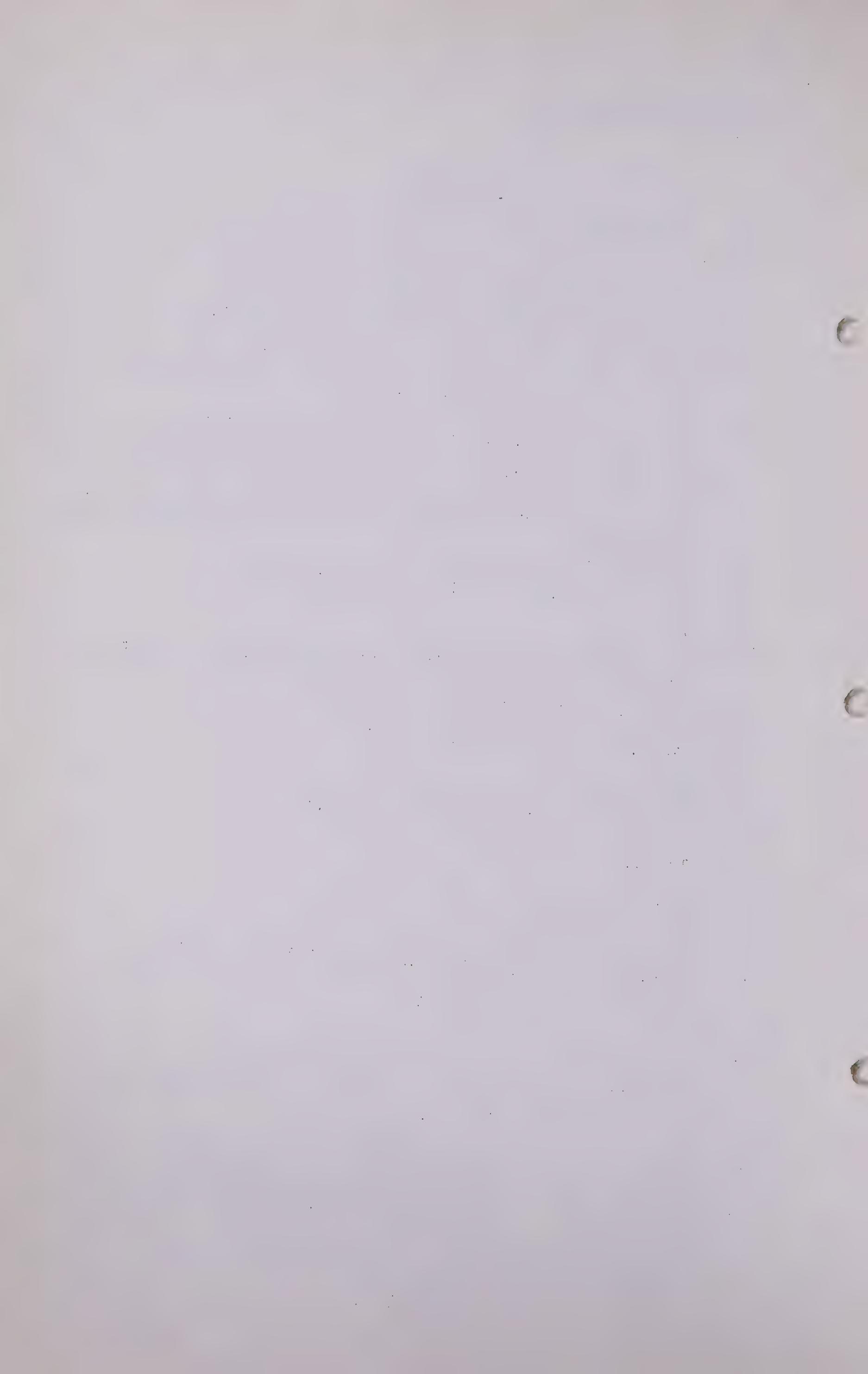
Q In 49-12 you have taken in the whole township, that is 36 sections, is it not?

A Yes.

Q That is 36 and 32 are 68 and then in 49-11 we have 32 square miles?

A That is correct.

Q That makes 100 square miles?



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A Yes.

Q You say it is those Viking wells in the south east corner of the township that should be considered as well as the 3 dry holes and the 1 small commercial well that I mentioned to you?

A Yes, that is quite right.

Q That whole area you refer to as proven commercial gas land?

A Yes, sir. There is no indication that the reservoir search suddenly goes from 10 or 11 feet in the south west corner of that to zero inside of a mile. There is gas saturation extending across that township as indicated by the well.

Q Your answer to my question is "yes", is it?

A Yes, sir.

Q That this is good commercial gas land?

A Not commercial.

Q That was my question, is it good commercial gas land?

A It might be graded commercial but I am not saying by wells being drilled on the surface that it can be graded commercial.

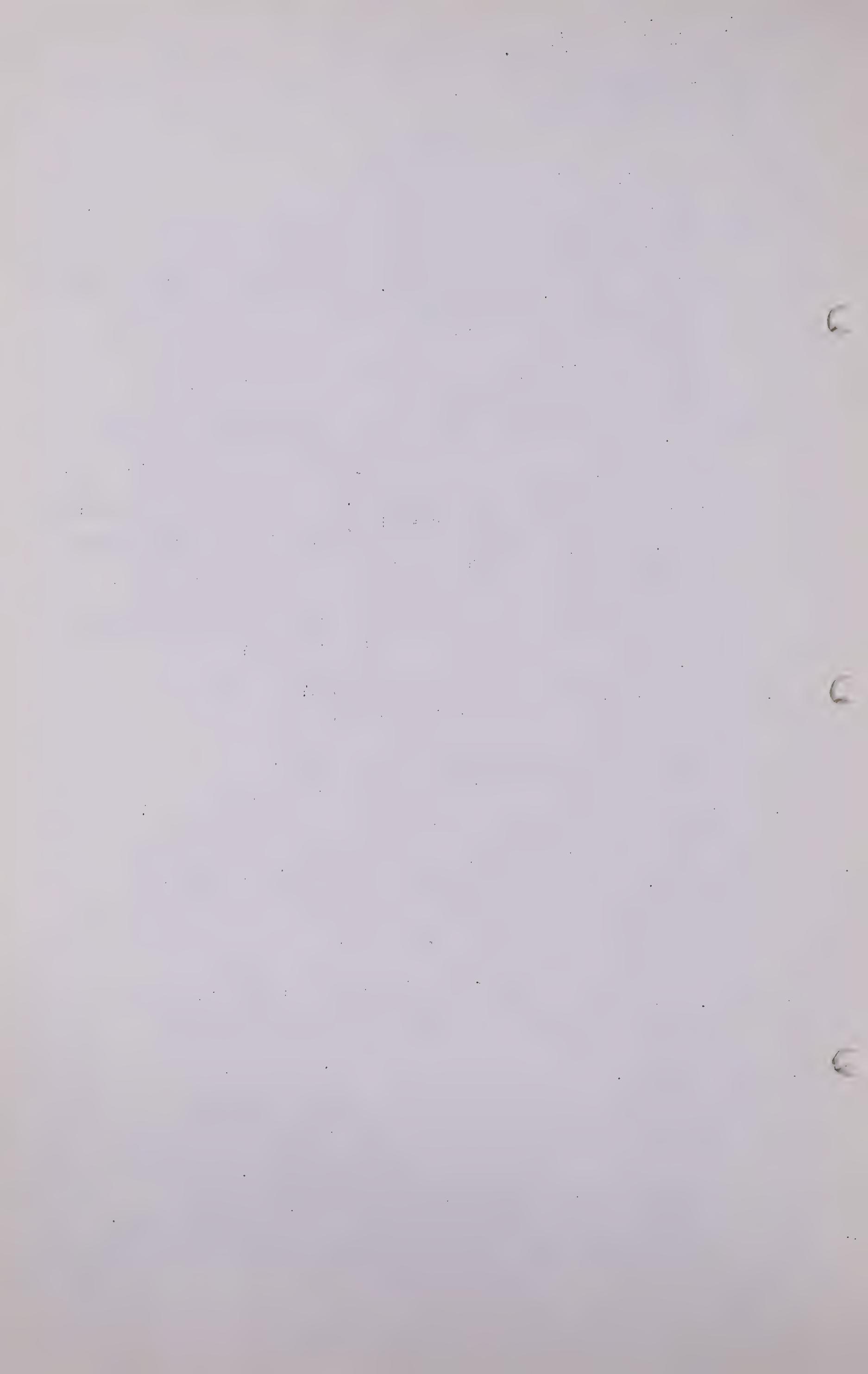
Q And then in your possible area outside of the 496, you have got an area of 683,300 acres, is that right?

A Yes, sir.

Q That has an average thickness, has it, of what?

A Something between zero and 2 feet. We have used an average of 1 for purposes of computation.

Q And the thicknesses in what we have been talking about a few minutes ago, the marginal area outside of Mr. Davis'



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245,000, in your proven area, vary from . . .

A . . . 2 to 10, plus or minus.

Q The difference between 2 feet thick sand in one and in the other area is what?

A Well you might say the average is approximately somewhere in the order of  $7\frac{1}{2}$ . Between 6 and 7 or  $7\frac{1}{2}$  and 1 foot. 6 or 7 times the acre feet volume between the two areas.

Q In the section I call the outside proven area or in this possible area?

A Yes.

Q And you told me the thickness of that possible area is what?

A I said approximately 1, I see in here it is  $1\frac{1}{2}$ .

Q Yes, that was just drawn to my attention. You call it estimated recoverable gas 244,194 million cubic feet?

A Yes, sir.

Q And in the area how many tests have been drilled?

A 22.

Q Will you look at 18-46-8. Section 18, Township 46, Range 8?

A Yes, sir.

Q You told me a while ago there is a showing of 3 feet of tight sand?

A Correct.

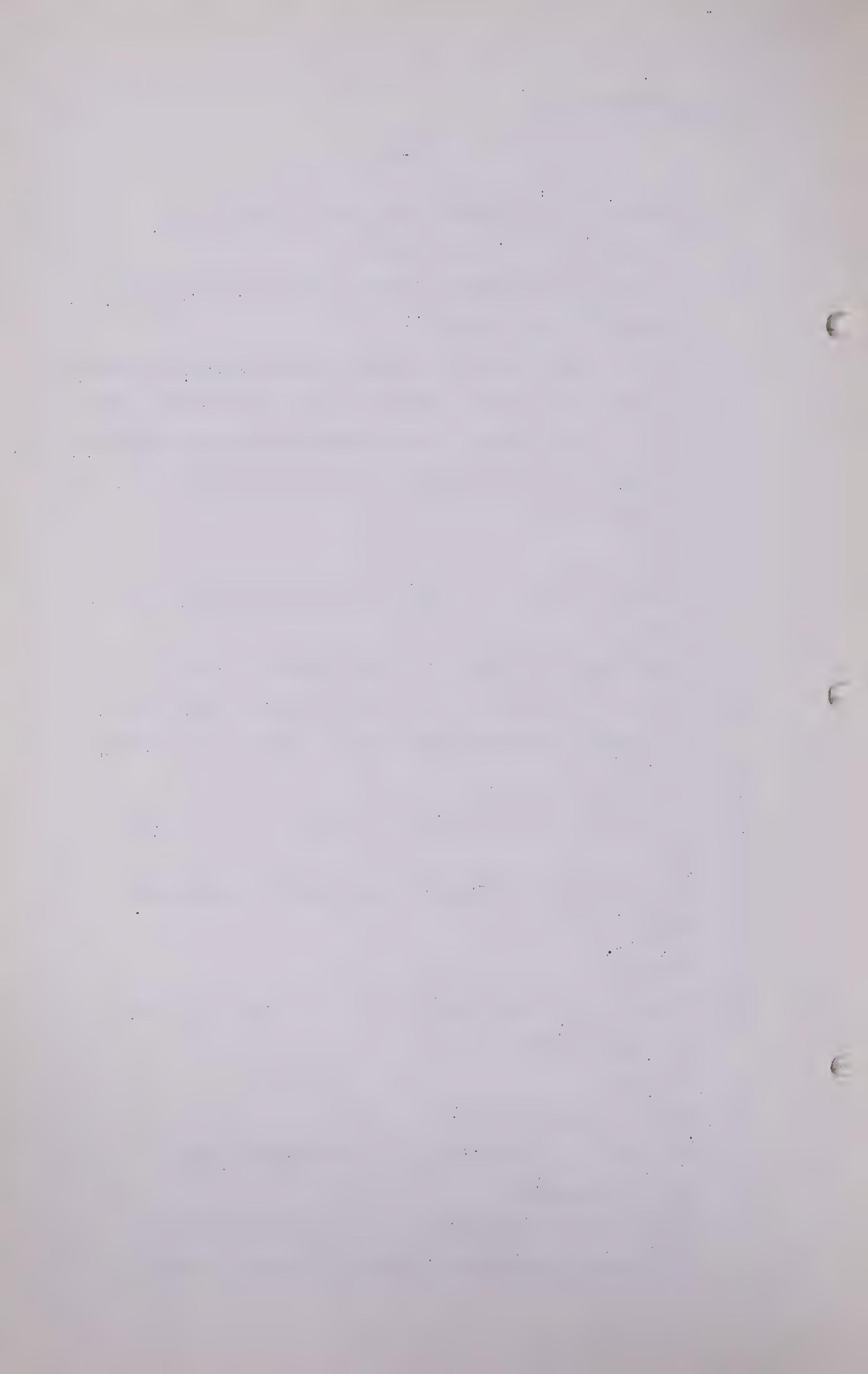
Q That well was abandoned?

A No, sir. That is gas-oil in the Devonian Dl.

Q Is it commercial?

A About 4 or 5 million feet, I believe. I think so,

Q Would you recommend the drilling of wells for gas in



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this area of 682,300?

A We have recommended no wells to be drilled there.

Q I ask you would you recommend a prudent operator to drill?

A I doubt very much. That volume does not appear in any of the calculations on which we considered the reserves. It is that it will make some minor contributions by reason of drainage.

Q Will you look at your isobaric map for 1950?

A Yes, sir.

Q A very substantial portion of that proven area had in 1950 an average bottom-hole pressure exceeding 800 pounds per square inch?

A In which year is that?

Q 1950. I say following the map a very substantial portion of your proven area . . .

A Yes, sir.

Q Would that amount to about half of it?

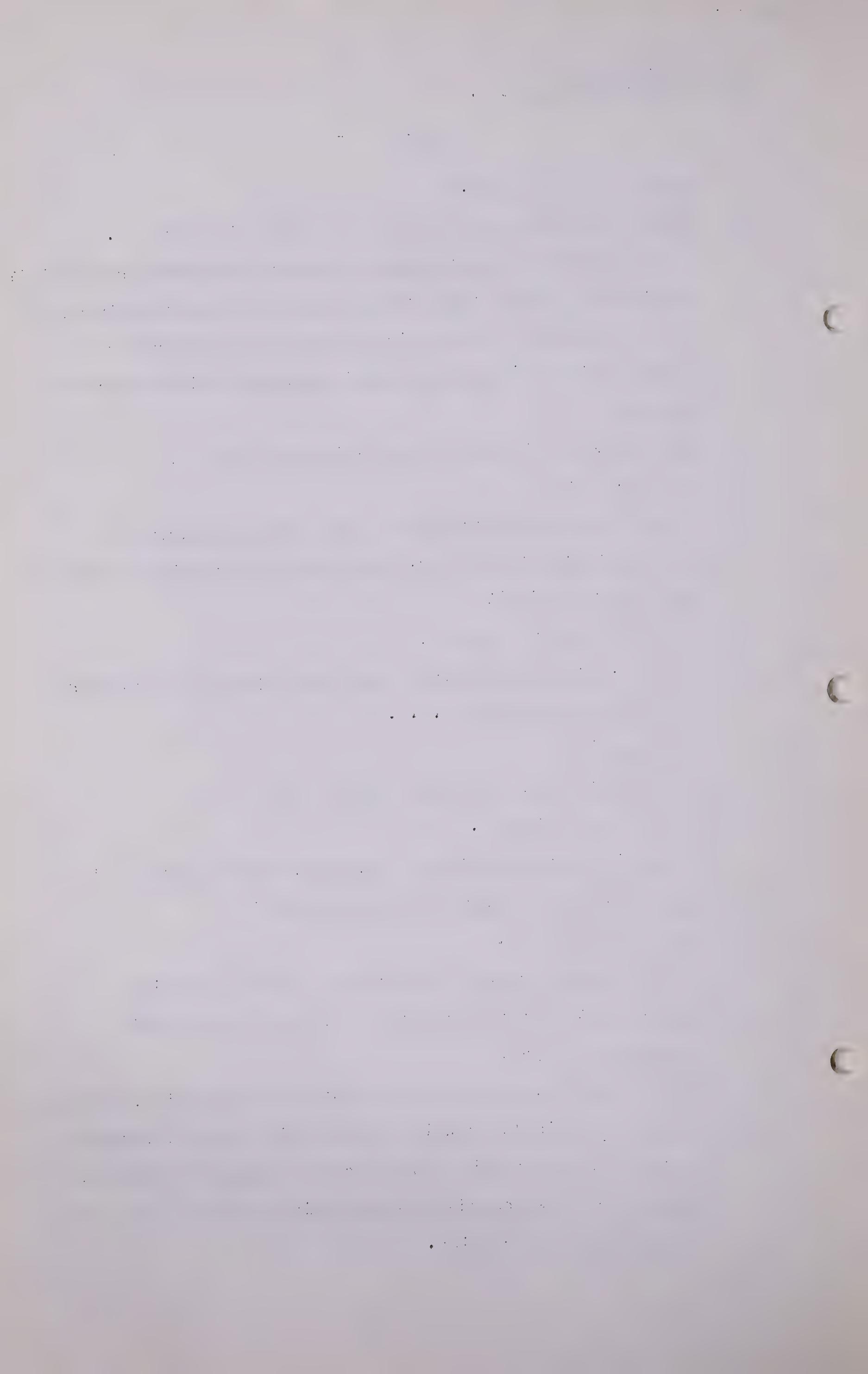
A I do not think so.

Q I think a study originally determined the bottom hole pressure at 809 pounds per square inch?

A That is correct.

Q And this would indicate that over a large portion of your proven area there has been to date a very slow drainage of gas?

A That is right, except in the south east extension, excepting around the isolated wells in Township 47 and 4<sup>6</sup>, Ranges 9 and 10 and in 50 there were pressures ranging from 80.3 pounds to 77.4 pounds. Those isolated wells in local areas of pressure depression.



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Q Would you agree that gas would flow much more readily in the better portions of the field where about the average thickness of the sand is more than 8 feet as compared to the flow from the marginal area where the average thickness of sand on your evidence is  $1\frac{1}{2}$  feet?

A Not necessarily. That is permeability. It is not necessarily a function of thickness. You may have a fairly high permeability in 1 or 2 feet of sand in which the total volume of pore space might be small and you might have a higher gas flow than in a thicker sand with lower permeability. But generally that is true.

Q That is to say, your answer to that is the higher permeability in the outside area, than in the proven area that is inside?

A No, I said a 1 foot sand might have a very high permeability. It is not a matter of thickness.

Q Would you look at page 6, Census Division 10?

A Is that the pressure map?

Q Yes.

A Page 6?

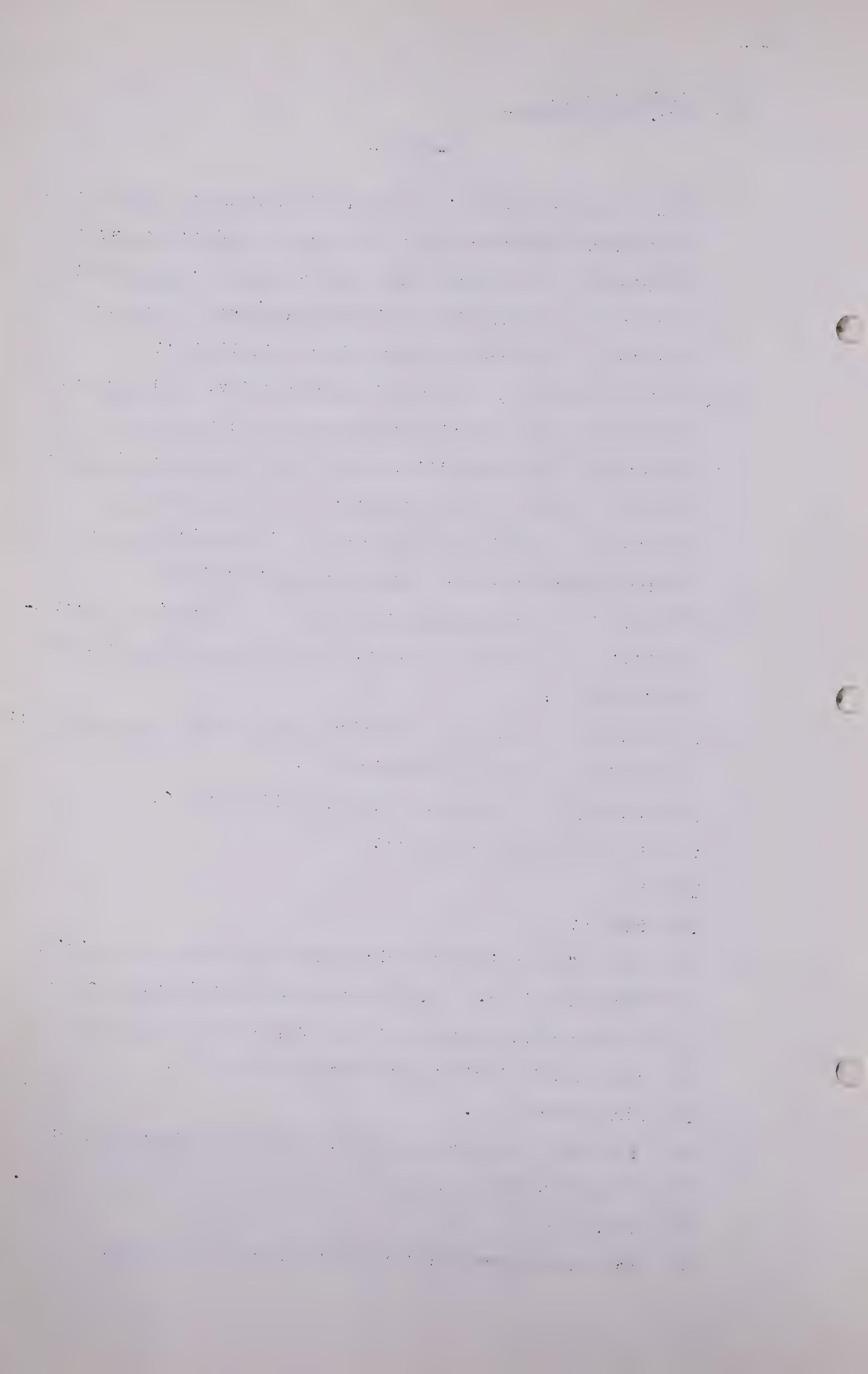
Q Yes. "Composite Isobaric-Isopachous Map 1950 of Viking Kinsella field." As I understand your isopach you have a few areas, very modest in size, where the thickness of the sand is indicated at more than 20 feet?

A That is correct.

Q You have other areas larger, where the thickness varies from 15 to 20 feet?

A Yes, sir.

Q You have a very substantial area where the average of



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the sand thickness varies from 15 feet down to 10 feet?

A That is correct.

Q And another substantial area where the thickness varies from 10 feet down?

A Yes.

Q Can you tell me how thick those sands are that vary from 10 feet down, does it go from 10 feet down to zero or to some other figure?

A In which area?

Q The outside area. We are talking about the area around the central area where the thickness varies from 10 feet down to - and I want to know the lower limit of down?

A About 4 feet. In well No. 40 in Township 48, Range 9, as shown on page 6, that well is the easternmost well in that Township. That is an electrolog determination of the thickness.

Q I am going to suggest, Mr. Dougherty, it would have been better to draw your isopach at 2 feet intervals rather than 5?

A That is straining at gnats and swallowing camels. Some of the data is not that good, much of it is not.

Q Let us look at well 26 in 13-48-10?

A Yes, sir.

Q You have indicated a 23 foot thickness?

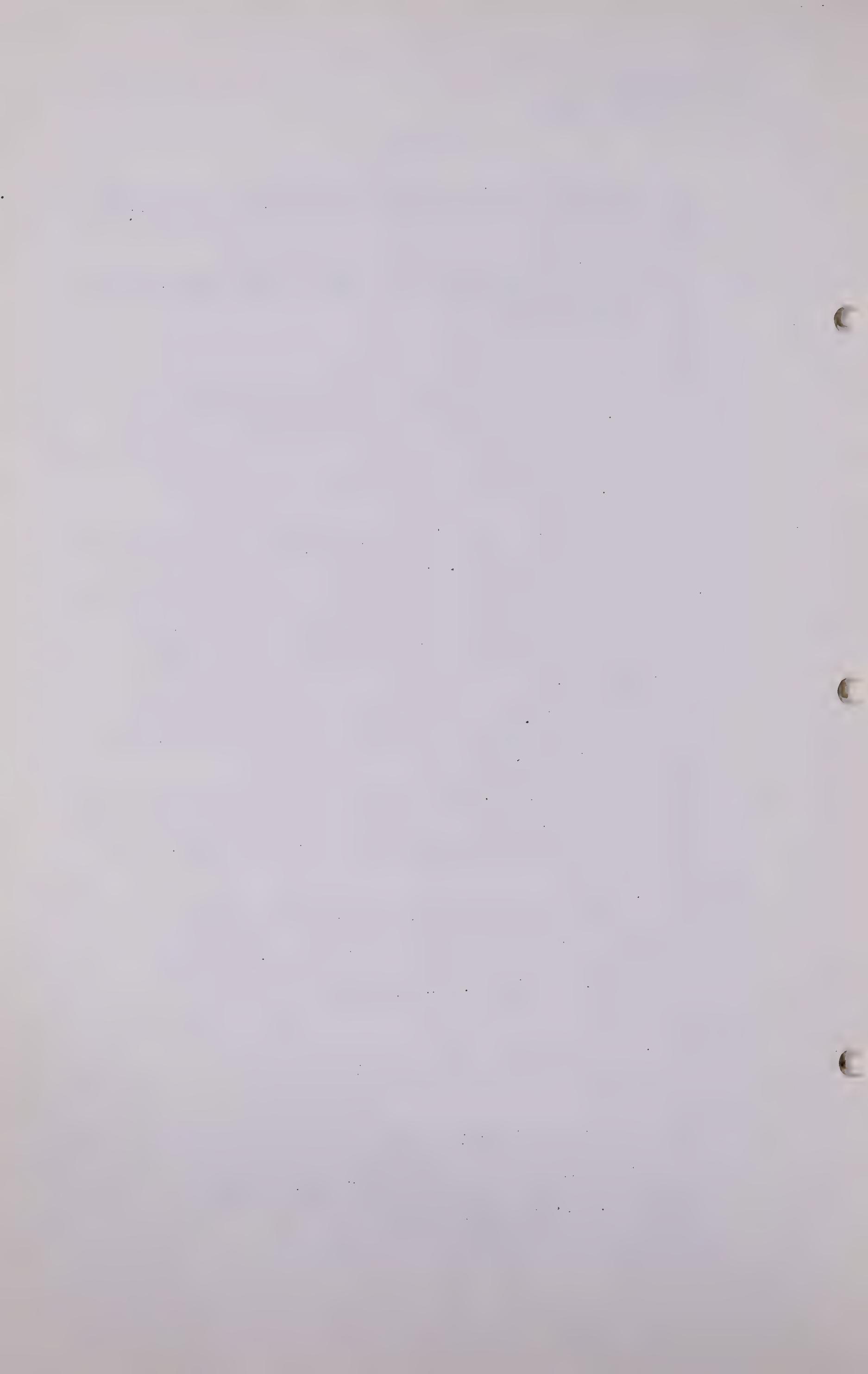
A Yes.

Q Where did you get that figure?

A We have the core analyses and the electrolog.

Q Well No. 14 in 29-47-Range 11?

A Yes, sir.



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Q You have shown there a thickness of 22 feet?

A That is correct.

Q Now will you assume this, that we have got a core description which is as follows from 2075 to 2085 sandy shale grading into sand. I am suggesting to you you would not assign much pay to that 10 feet of core if that is the proper description of it?

A Is that Well No. 14 you are talking about?

Q Yes?

A I do not think there is a core that we have referred to on that.

Q I am asking you to assume that we have a core.

A Have you? I would like to know.

Q We have, yes. I am instructed we have a core.

MR. C. E. SMITH: You had better get their little black book.

A That core analysis was not put in in Mr. Davis' submission in April 23, 1951?

Q MR. STEER: I see.

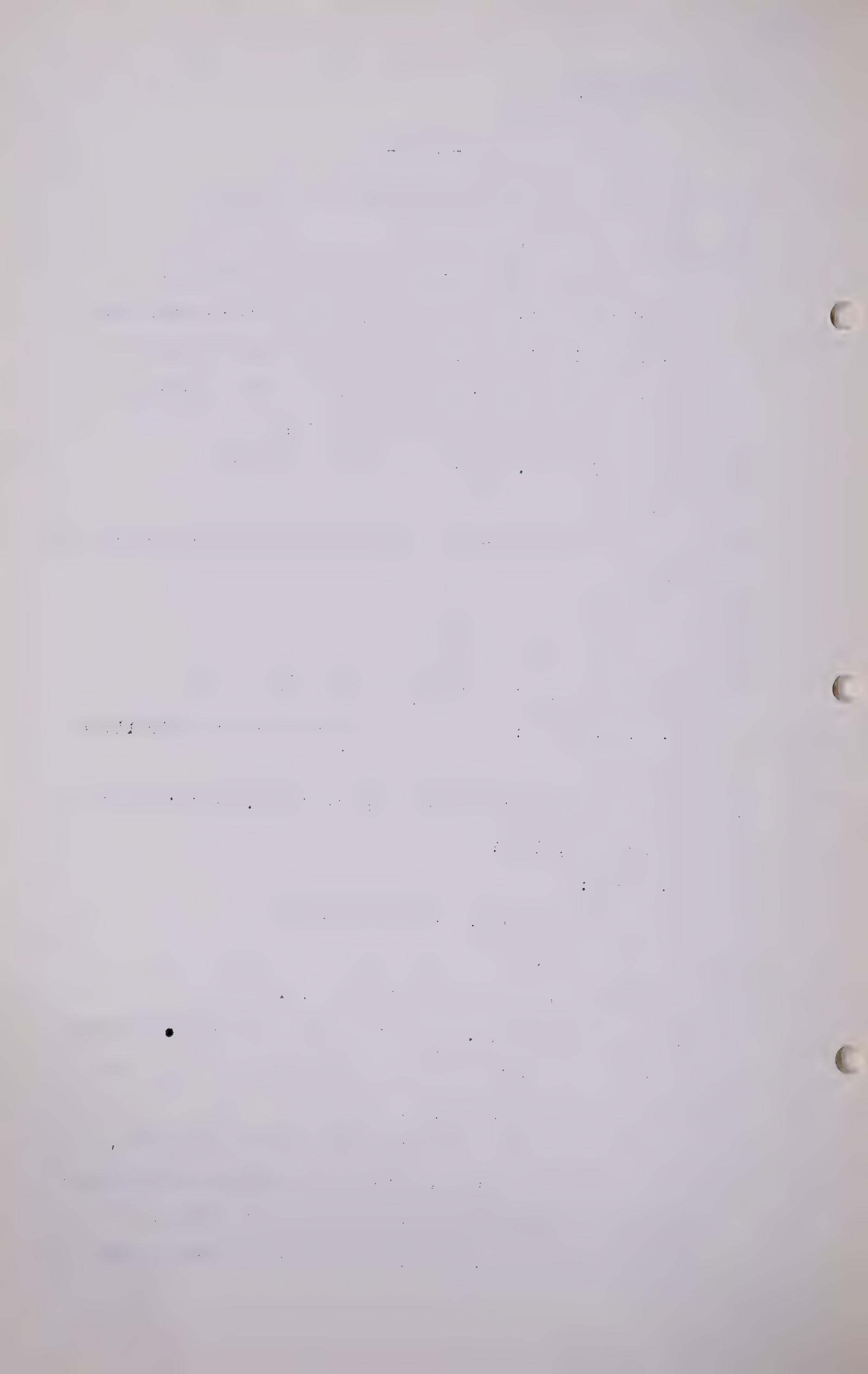
A I ask that question. I just wondered.

Q I do not know.

A I gathered that these submissions . . .

Q Let me ask you this. Assuming that a 10 foot core shows sandy shale grading into sand would you expect to get much gas out of that sand?

A If there is a core analysis I would rather see that, because this description might be made by a tool dresser or a driller or anybody who happens to be there. It depends on what you mean by sandy shale or shaly sand.



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We might be able to do something.

Q I wonder if it is any use of me going any further?

A I have my doubts.

Q I am going to suggest that we have got from 2085 to 2089 a recovery of 4 feet described as sand shale with some sand. And then we have the 10 foot core.

A I have to place that with respect to the top of the Viking. I could get the electrolog on that if you would like to discuss it. But I would also like to see the core analysis.

(Go to page 494.)



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Q I think we will not bother with that, Mr. Dougherty.

A I wonder if I might have access to the core analysis at some later date?

I will be glad to go into it with you if I thought we could get anywhere, and I think what we will do is call Mr. Davis with regard to those things and he can prove them and Mr. Porter can cross-examine him.

MR. PORTER: It would be useful to have the core analysis of that.

MR. STEER: You could have had them at any time by applying to the Northwestern Utilities but we will furnish them.

MR. PORTER: Thanks very much.

Q MR. STEER: Now then, I want to ask you just a few questions on Princess-Patricia. What do you understand the Princess-Patricia area -

A If I might have just a moment to dispense with these.

Q Surely.

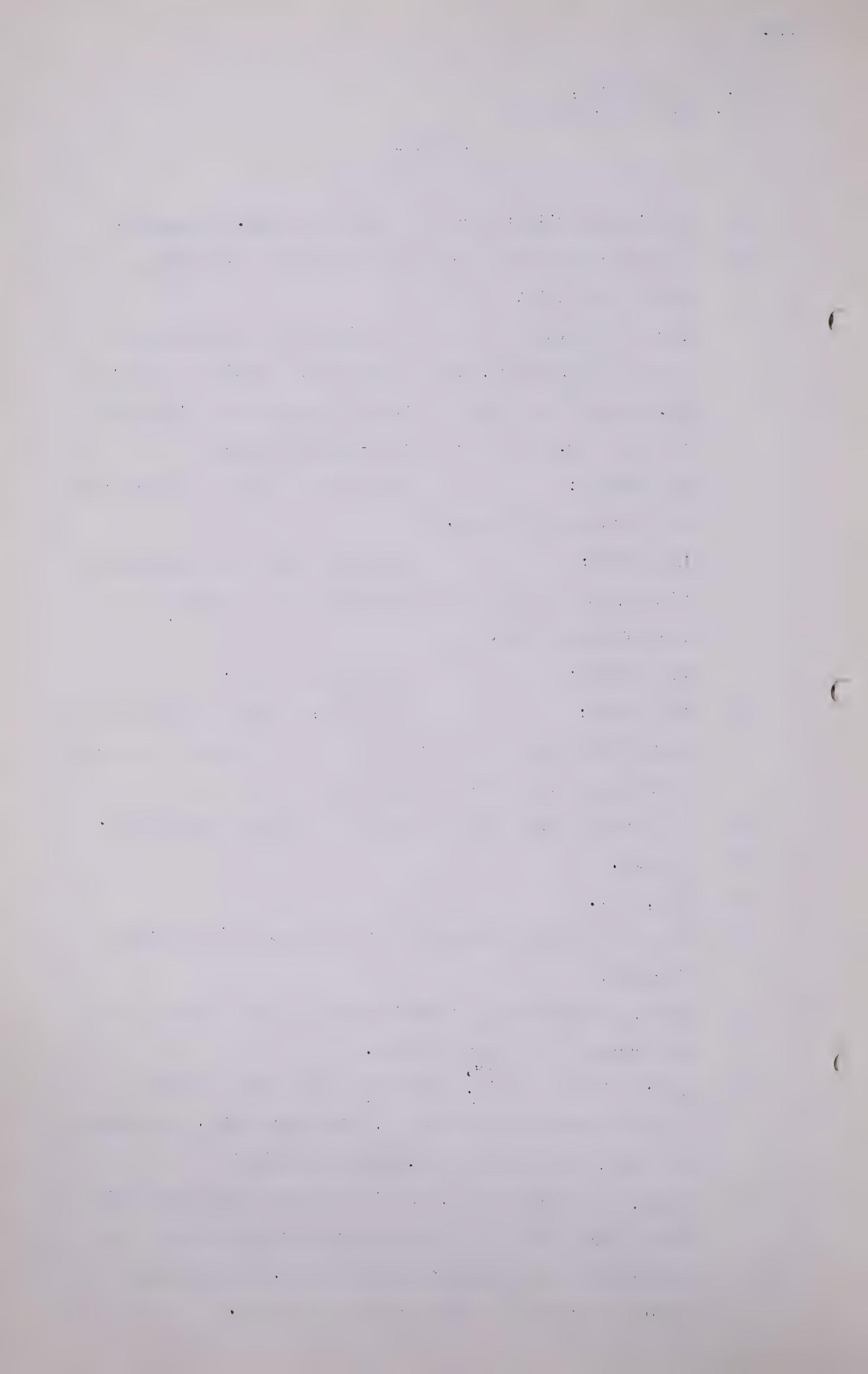
A Yes, sir.

Q What do you understand this Princess-Patricia area to include?

A Well, I think the best definition of that would be by referring to the map exhibit.

Q Let me ask you this; would you agree that it runs between Townships 18 and 22, both inclusive, and Ranges 7 to 15, West of the 4th, both inclusive?

A Well, not necessarily. We included Rolling Hills and Tilley and Bantry in that general Princess area. In other words, I would say the central, west central portion of census division 3 would be it.



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Q You understand I am talking about the area of your census division 3. That could all be described as Princess-Patricia area, could it not?

A With the exception of Medicine Hat which runs across into it. In other words, the west half could be called the Princess-Patricia area, yes, sir.

Q Would that description I have given you be satisfactory?

A Fairly close.

Q Between 18 and 22, both inclusive, and Ranges 7 to 15, both inclusive?

A Pretty well, yes.

Q That I figure to be 1620 square miles?

A Could be.

Q Do you know how many wells have been drilled in that whole area? I am suggesting to you that there have been 80.

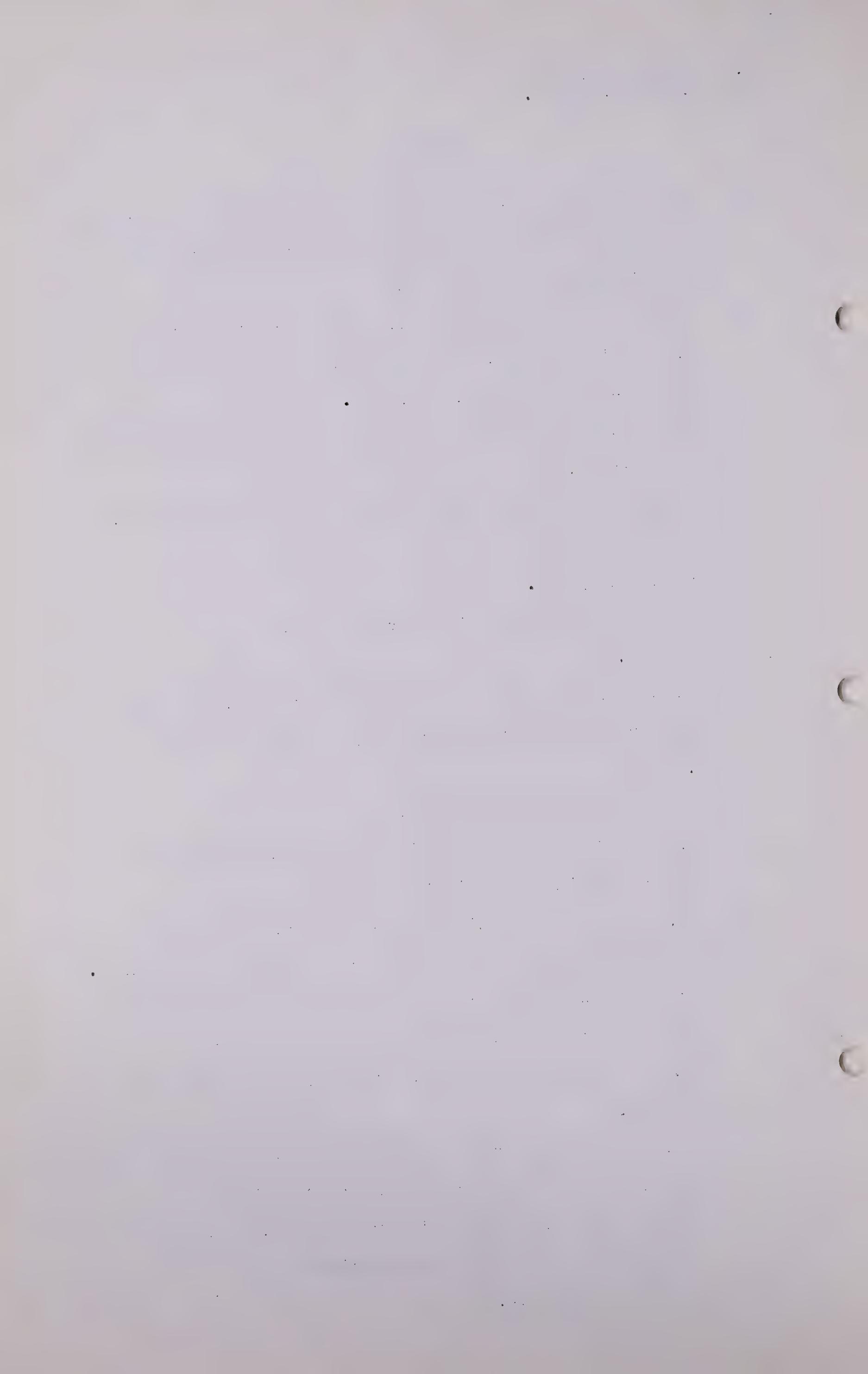
A That sounds not unreasonable.

Q Yes, and of those 80 wells in the general area there are 7 commercial gas wells?

A Well, there you meet with this qualification again. I do not know what a commercial gas well is, essentially. There are a number of capped gas wells, some producing gas wells and potential gas wells with gas tested in the sand. I would not ignore one category in preference to the other.

Q I see. Would you agree that there have been 22 oil wells drilled, some of which have been abandoned?

A I think that is probably not unreasonable. I do not have the figures. Oil wells in the Madison and in the Jefferson formations.



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Q Are you accepting our definition where there are 36 dry holes drilled?

A That is quite possible.

Q And whether they be very dry, I mean, could we say they were dry holes without our qualification?

A Well, I do not know which ones you have. I would be delighted to go through it in detail.

Q Perhaps we had better establish it.

A Yes, sir.

Q MR. PORTER: You do have information on those wells, have you, Mr. Dougherty?

A Yes, sir.

Q Well, answer the question by giving the information that is available to you and there can be no assumption when there can be testimony.

Q MR. STEER: If you have the information, Mr. Dougherty, I will tell you what I would like you to verify for me. Within this whole area there have been, perhaps you will take these figures, 6 gas wells, there have been 17 possible gas wells, there have been 20 oil wells and 39 dry holes.

MR. PORTER: I wonder if I might ask my learned friend to give me again the acreage in the area?

MR. STEER: The acreage I have given, 1620 square miles. That is what I gave you.

A I think the only intelligent way to discuss this would be by the fields as we have set them up and I can do that quite readily by fields, by sand from the Bow Island into the Sunburst. We estimated reserves in the Bow



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Island Basal Alberta and the Sunburst sands and we could go through the Exhibit 10, or better, 4-A, and I could give you the wells which control the proved area, the gas-water contacts, all the miscellaneous data, if you so desire.

Q Is this a long job, Mr. Dougherty?

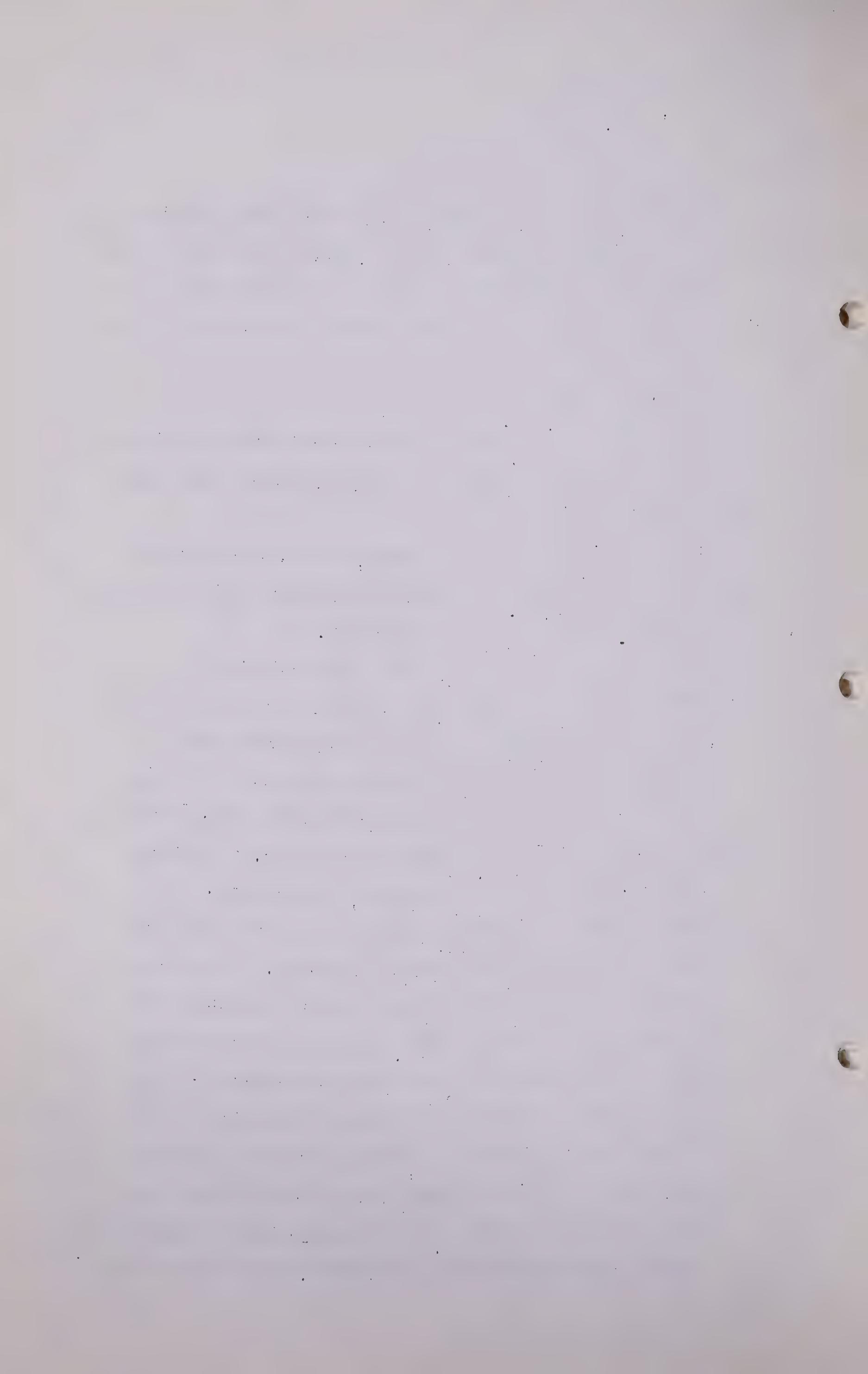
A We have a lot of data. We could start with Exhibit 4-A. That is volume 1, census division 3, page 1 and pages 25, 26 and 27.

MR. C.E. SMITH: Exhibit 4, is it, not 4-A?

A I beg your pardon, 4. The first field I refer to would be Bantry-Tilley in census division 3.

Q MR. STEER: Where is it located?

A That is shown on page 25 up in the south centre of the map. Referring first to page 1 which summarizes the estimates, under Bantry-Tilley in the group of lines under 3, you will note we have Milk River sand, limited prospect, no estimate. Medicine Hat sand, producing local town supply, minor reserve, no estimate. Bow Island sands prospective, and note we have shown only probable reserves and possible reserves. If you will observe the map on page 25 showing the thickness of the Bow Island net gas sand, and in the Bantry-Tilley area we have shown some probable gas reserves. The Imperial No. 1 northwest of Tilley in Section 18 of 17, Township 17, Range 12, West of the 4th, the drill stem tests in the Bow Island sand showed gas and some water in volume stated. By electrical log interpretation have an indicated probable thickness of around 24 feet.



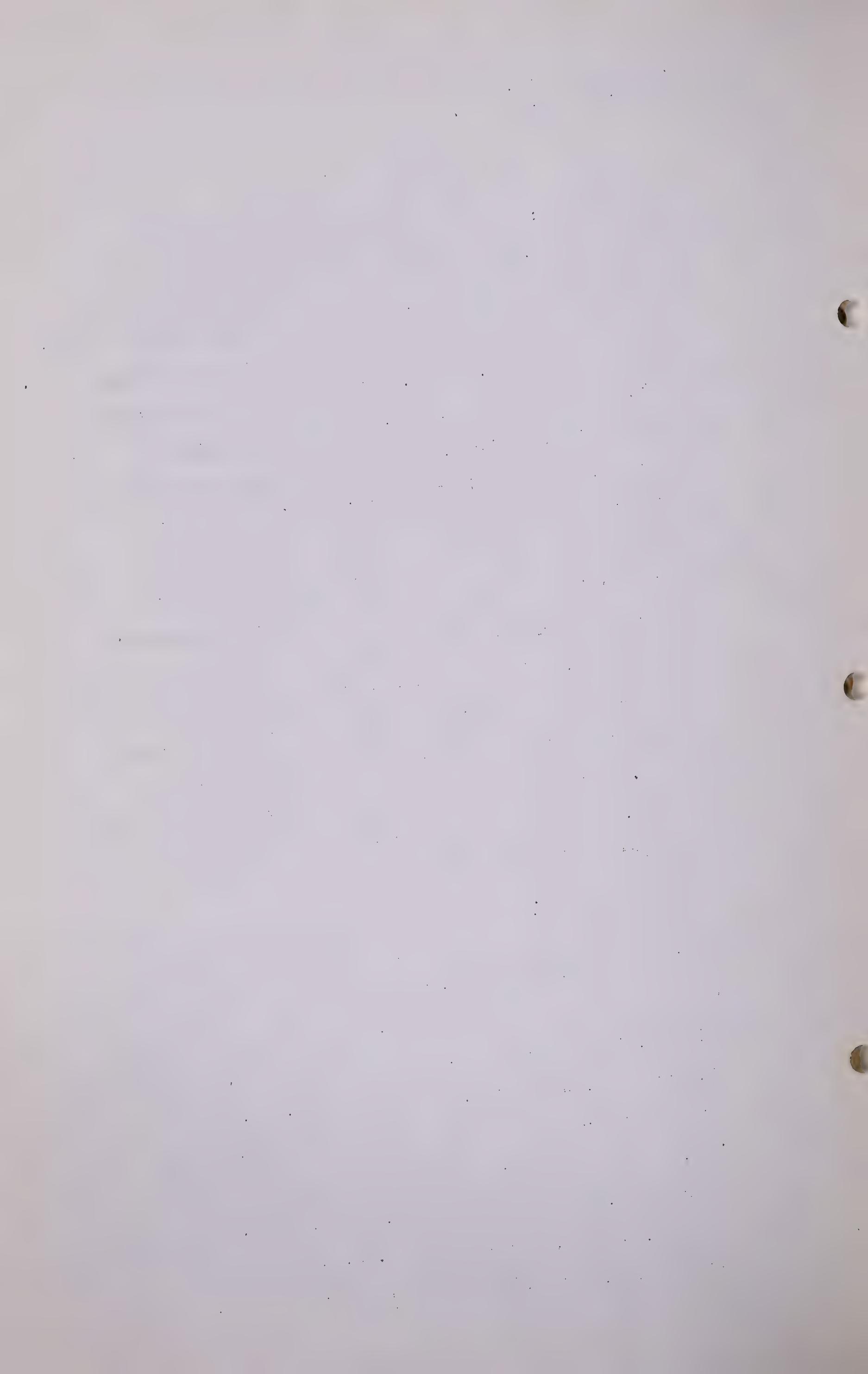
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Q MR. DAVIS: What section is that in?

A Section 18. That is the well just southeast of the little town of Tilley. We have set no proved reserves, there is no completed gas well there. Then another well, Cal-Standard No. 37-35, Bantry, in Township 17, Range 13, West Section 35, Lsd. 15, an old well, drill stem tested 2469 to 2540, gas in 13 minutes, volume not stated. That is in the Bow Island. Mind you, these wells were drilled some years ago for Madison and Jefferson oil before there was any market or even prospecting these long distance transmission lines. We counted in this area estimated net sand thickness on 7 wells, note by thickness ranging between 4 and 24 feet all in the probable or possible categories, since we had no definite volume measured in the drill stem tests, although there are records of gas in the Bow Island. We think it is a prospective and probable area and that a diligent effort to drill gas wells will produce some proof.

Now, referring to the Sunburst horizon in Bantry-Tilley, you note we have shown again probable and possible reserves. We have these wells for control, the Imperial No. 6 Northwest Tilley, Township 17, Range 12, West of 4, Section 7, Lsd. 16, estimated net sand thickness 5 feet, drill stem tests 3172 to 3200, 5 million cubic feet plus two stands of oil; Imperial No. 4 Northwest Tilley, Township 17, north, Range 12, West 4, Section 17 Lsd. 5, drill stem tests 3162 to 3166, 3 million 200 thousand cubic feet,



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recovered no oil and no connate water, estimated net sand 5 feet. Completed 4-42, produced gas, abandoned in October 1945. Township 18, Range 13, West of the 4th, Section 2 Lsd. 1, Cal-Standard No. 11-2, Imperial-Bantry, estimated net sand 12 feet, drill stem test 3245 to 3253,  $2\frac{1}{2}$  million cubic feet plus oil to surface in 14 minutes, recovered 60 feet of oil, completed as a Sunburst oil well, 97 barrels of oil per day. Those wells indicated the presence of an area in Bantry - Tilley limited to probable and possible reserves. We did not attach too much to the Sunburst in that area.

Q MR. GOODALL: Any dry wells in that area?

A Yes, sir. Those will be seen on page 27, the Imperial-

Tilley wells that lie right on the pinch-out limit.

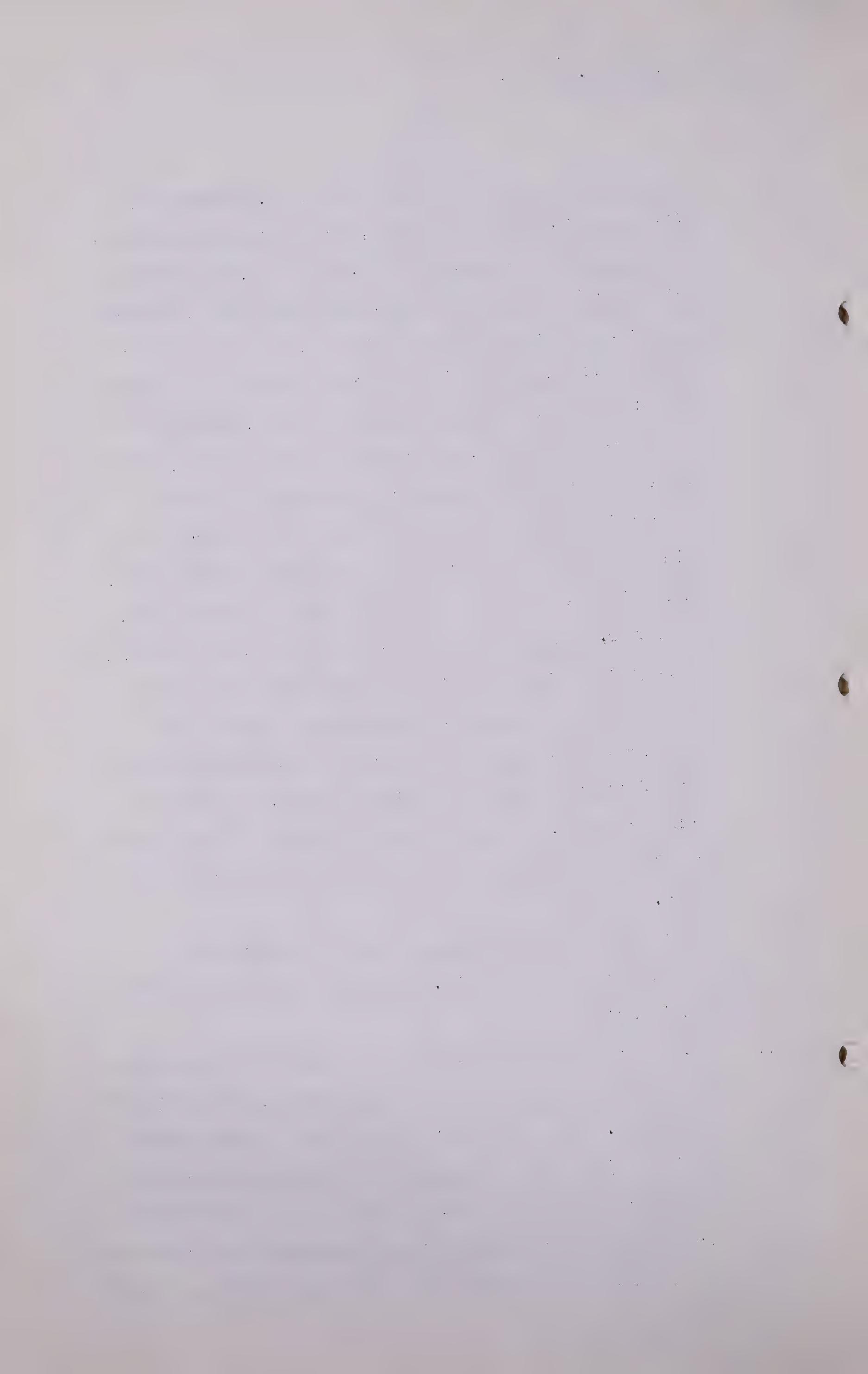
The dotted line shown at the southwest edge of the Bantry-Tilley, which is an up-dip stratigraphic change from Sunburst sand to no Sunburst sand, or Sunburst sand to shale, so that the area down-dip off the flank of the structure has possibilities for Sunburst production.

Q There were no wells drilled up-dip or down-dip?

A We will say to the south. You mean to the northeast?

Q Northeast?

A No. These features were all, or most of them were, shot with seismic crews and they stayed pretty well on the highs. We made a structural map - I might just indicate just for reference - on which we attempted to infer or structure the entire area as the basis for achieving some control on these accumulations and carefully checked the electrical logs and drilling records



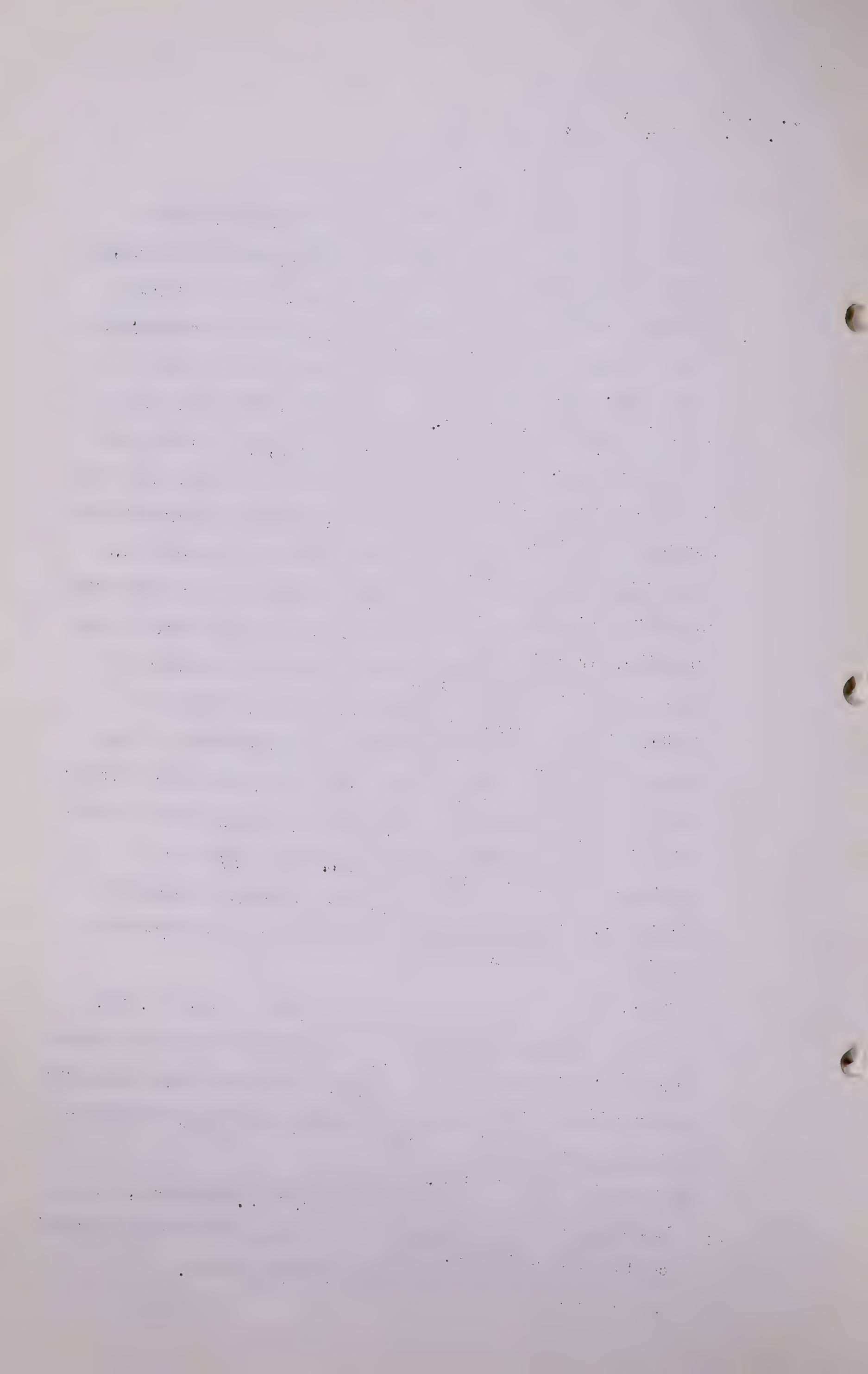
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to determine where the sand was absent and where we might infer it to be present off the flank of the highs, which is typical of Sunburst occurrence. It is shaly Madison on top of the Madison, erosional in conformity at that point, which can be pointed out in some detail in the Princess field proper. I might add that on the map on page 27, in the centre of the map, you will note in the Princess area the south half of it shows that the Sunburst is absent or tight. We obtained that data from electrical log correlation and sample log correlation, and more recently that has been verified by conversations with Mr. Crockford who sat on several of those wells and confirmed that the Sunburst was absent in a number of them. That is fairly typical of the occurrence of Sunburst and we have restricted the occurrence to the flanks or to the tops of those Madison highs which either produced oil or have not produced oil as in Brooks Northeast where the Sunburst goes across the top of the feature. We showed no proved or probable or possible Viking or Basal Alberta production in the Bantry-Tilley area.

You will note on map No. 26, page 26, census division 3, that between the dotted lines sub-surface control would indicate that the Basal Alberta may be present but we can not demonstrate any possibilities for production.

Q MR. STEER: I wonder, Mr. Dougherty, if you could shorten this. I asked you some questions all right and I suppose you are trying to answer them.



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A Well, we do not give out the number of wells over so many square miles or hundreds of square miles. We expect the accumulations to be located in the structurally and stratigraphically likely spots. Your discussion involving the entire area is meaningless.

Q Do you regard the Bantry-Tilley area as of commercial importance?

A We put it at probable and possible. I think for Provincial supply and locally supplementing the Town of Brooks and vicinity it is quite possible and even probable.

Q I wonder if you would go over the area that we have been talking about and pick out for us the commercial gas?

A I do not like the term "commercial gas".

Q Well, let us say your proven gas?

A I am discussing proved and possible and probable reserves and areas which have no gas markets.

Q I think it will answer our purpose if you go over this map and point out for us on the map wells which you say demonstrate your proven gas in this particular area.

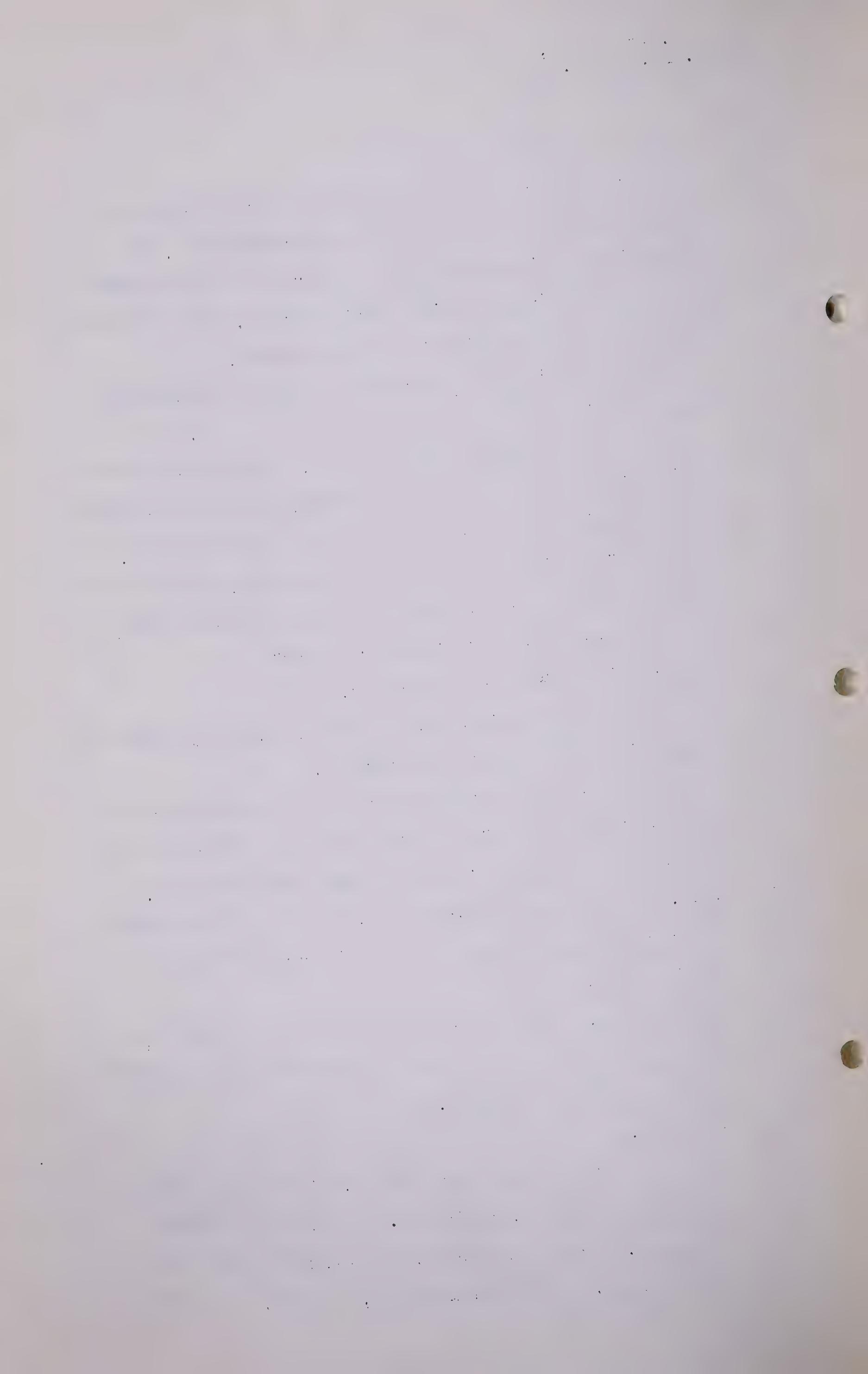
A Well, we considered proved and probable as very similar categories and those wells studied in Bantry-Tilley --

Q Are included?

A Are included, and I expect to do the same for each of those fields in order to make it perfectly clear on the record what our reason was.

Q All right.

A You might refer next then to Brooks, line 6 on page 1 of census division 3, Exhibit 4. We have the Milk River sand, local town supply, Bow Island sands as only possible. The Bow Island map, page 25, up in



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Brooks has some indicated thicknesses that would indicate possible gas reserves. In Bow Island the Canadian Western Natural Gas No. 1, Township 18, Range 14, Section 20 Lsd. 16. This is the only deep well in that area. Total depth 3339 feet in the Madison. It is the only well we have electrical logs on. There is no drill stem test in the Bow Island but the electrical log characteristics indicate a possibility.

(Go to page 503)



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Q Yes?

A It is unsupported by tests. However, we have set it up as having some possibility of being productive of gas.

Q What is the location of that?

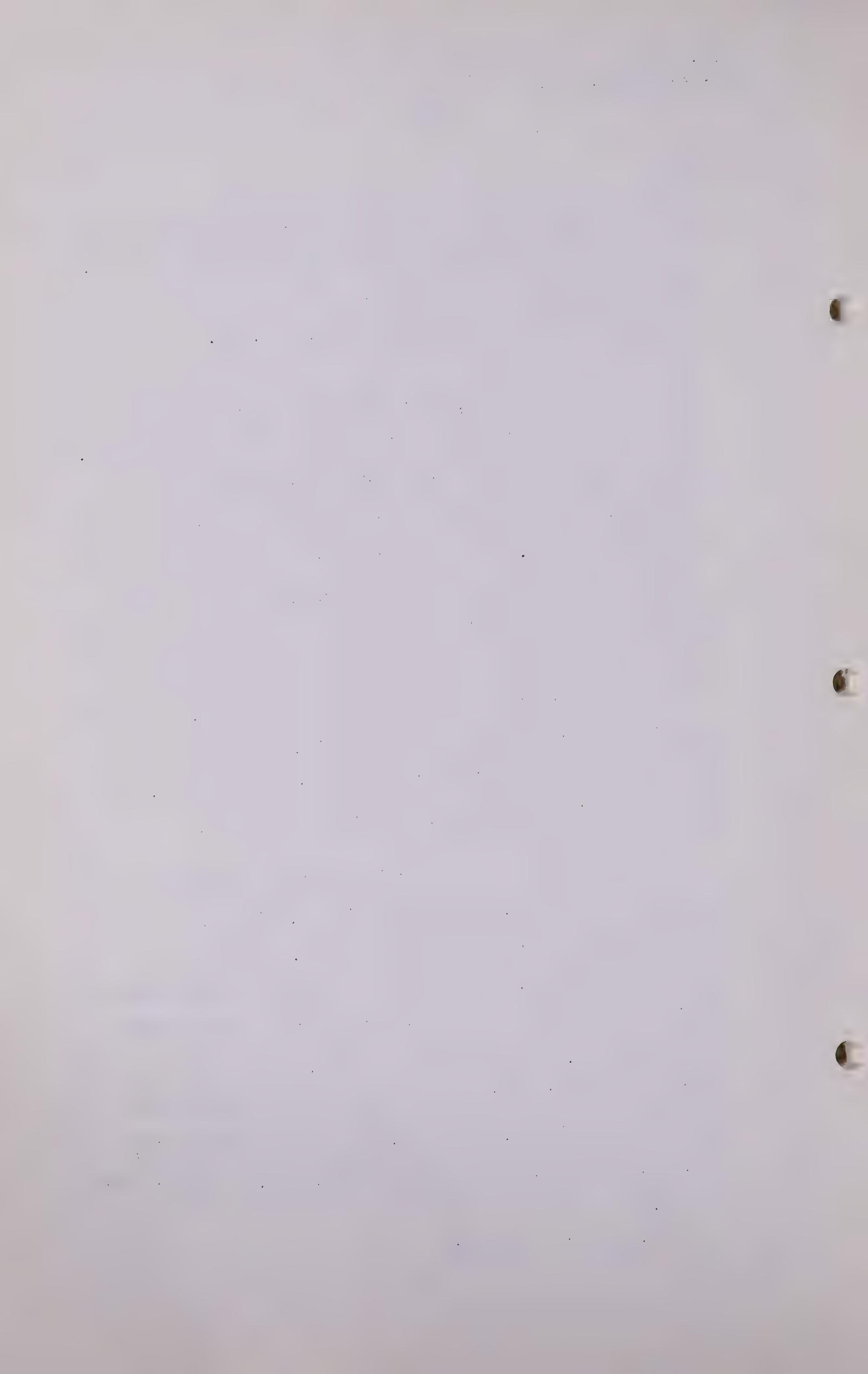
A Township 18, Range 14, Section 20, Lsd. 16.

Q Yes?

A However, in Sunburst, that same well apparently may have encountered 155,000 cubic feet of gas in the Sunburst. But we cannot find the authority for that notation on the log, so that we did not assign any Sunburst probable or possible gas. We could not place the position of the drillstem tests which may have represented that volume, so that that there might be still a Sunburst possibility there, but between the electrical log and the lack of definite information as to where the test was, we do not consider it reasonable to include it. This same well was plugged back to 1504 feet, perforated at 1295, and is a Milk River gas supply for local town use.

Turning next to Brooks Northeast, which is on page 1, Census Division 3, line 7, we show the Bow Island sands as having proved, probable and possible reserves. Referring to page 25 in that Census Division, you will see our configuration of the limits of the proved, probable and possible. The proved is limited to the immediate location of the Cal-Standard well in Township 19, Range 14, West of 4, Section 13, Lsd. 11, drillstem test 2565 to 2605, 650,000 cubic feet of gas.

Q What location is that at?



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A I just gave that. It is in Township 19, Range 14, West of 4, Section 13. It is well in the middle of the heavy black line on the map, the proved limit.

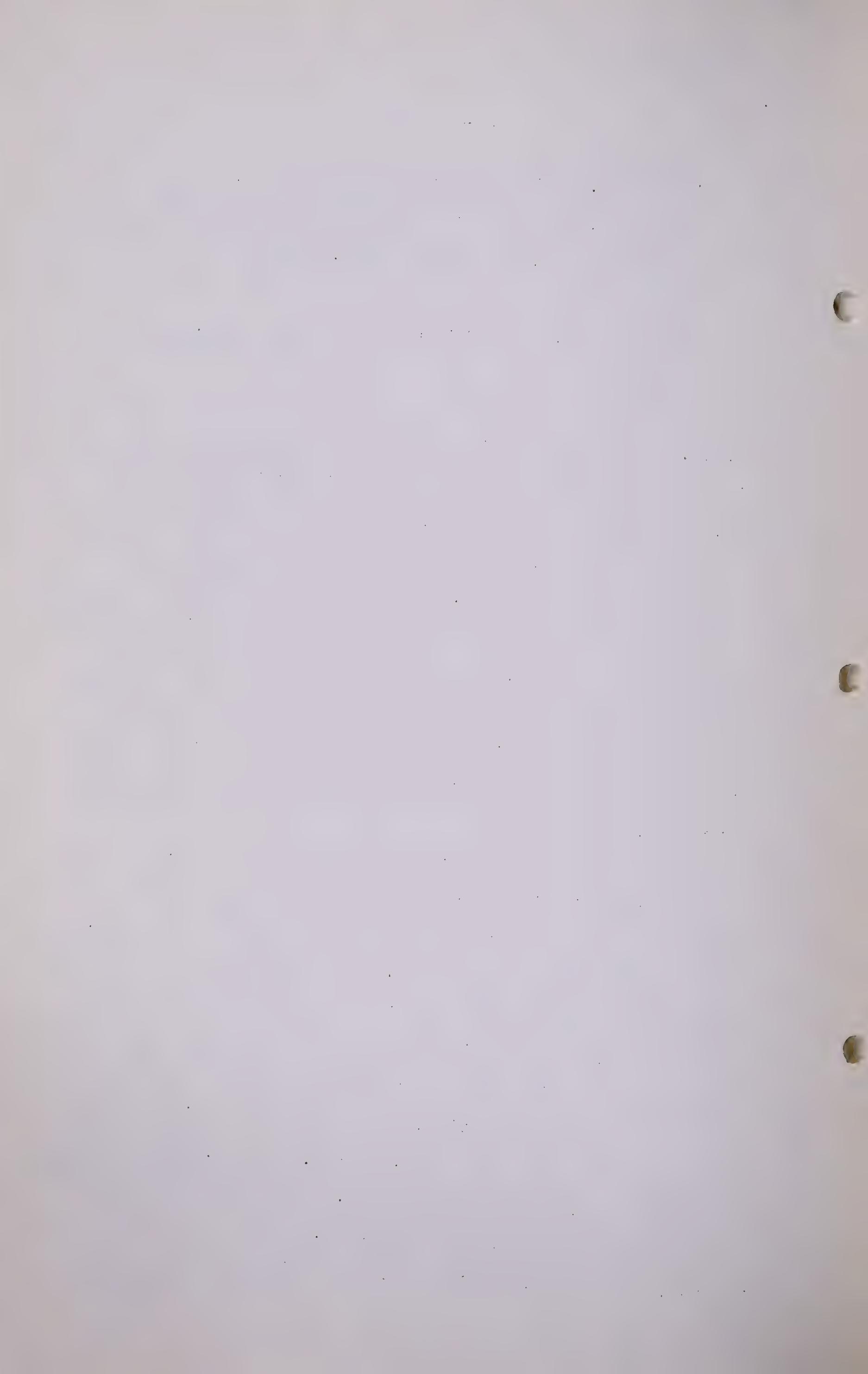
Q Section 14?

A Section 13, Township 14, Range 14 - no, Township 19, Range 14.

Q Thank you.

A Lsd. 11. From the electrical log we determined that the drillstem test was not taken in the best portion of the sand. We do not think the 650,000 cubic feet is representative of the sand, and that the true saturation is something in excess of that, but we have a definite proved volume of gas. We consider that area proved immediately around the well. Then, using that well as a key, we then made an electrical log interpretation of the surrounding wells, and estimated net sands as shown on the map, which gave the basis for the probable and possible areas of gas saturation.

Turning now to the next map, page 26, and referring again to page 1, we show the Basal Alberta in the Princess having reserves in the proved, probable and possible categories. We estimated that there was a good gas/water interface at minus 497 feet in the Basal Alberta, and there is a note on the map that gave us a basis for indicating the approximate limits based on our structural interpretation, and we limited the information on the proved area to the wells, Cal-Standard No. 56-13 Brooks in Township 19, Range 14, West of 4, Section 13, and Cal-Standard 36-14, Brooks, in Township 19, Range 14, West of the 4th, Section 14, and the estimated thicknesses were 16



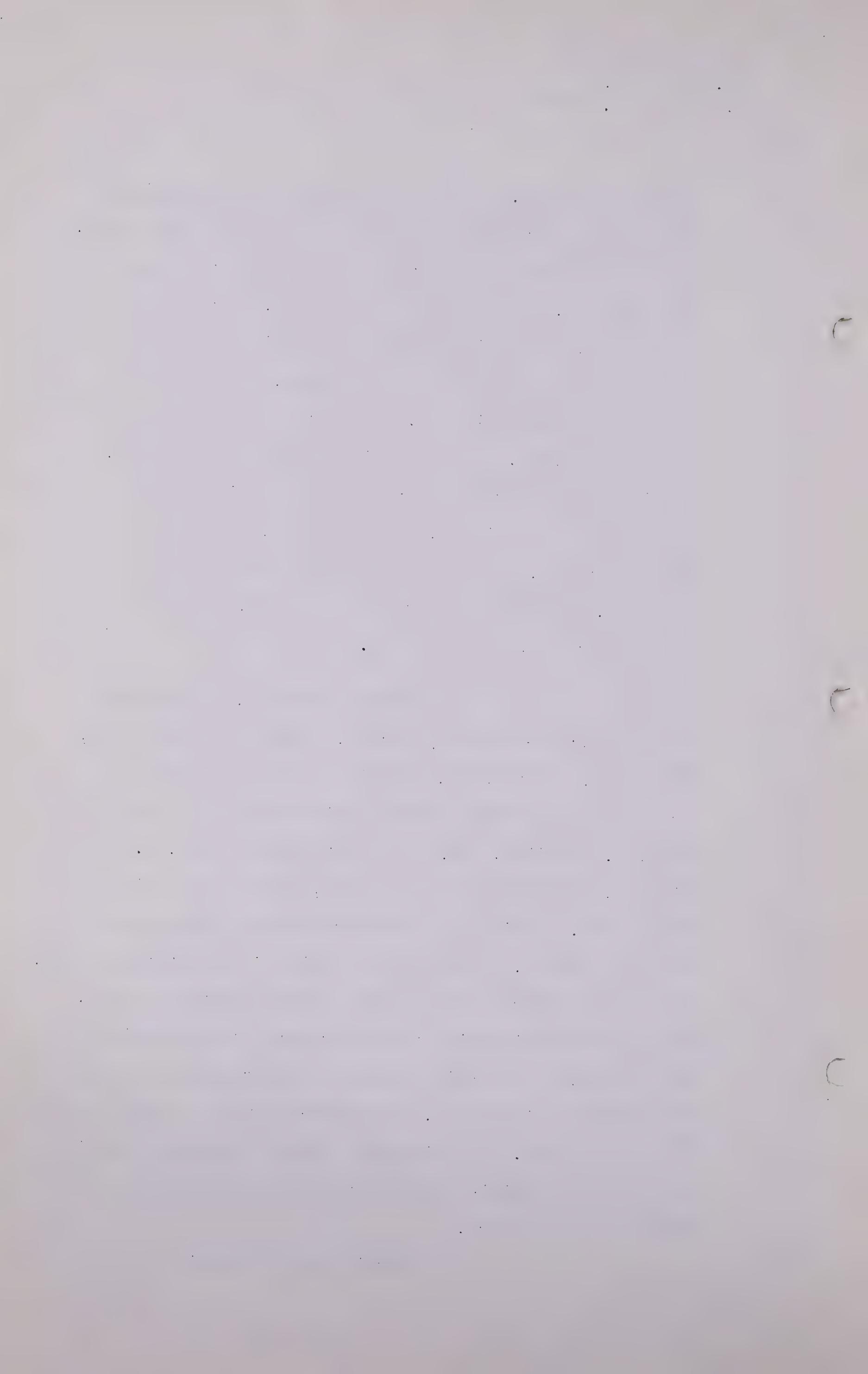
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feet and 10 feet. There is a problem of correlation between the Basal Alberta and the Third Bow Island sand, and the drillstem tests previously cited went across the interval, so that one or the other, there is gas in both sands, and it is possible that this Basal Alberta might be part of the Third Bow Island, but we made an arbitrary differentiation. It could have been in the Third Bow Island, but we put it in the Basal Alberta. We picked that Northeast Brooks as a promising area in a number of horizons. The Sunburst, referring to Map 27, page 1, we show as producing having proved reserves, probable and possible reserves, as part of the town gas supply of Brooks.

In the Sunburst, Cal-Standard No. 1 Princess-Brooks-Syndicate, Township 19, Range 13, West of 4, Section 17, that is the well on which the proved area is centred around drillstem tests 3278 to 3288, 1.7 million. Drillstem test 3278 to 3298, 1.8 million. Perforated 3277 to 3288, open flow 23 million cubic feet. This is the producing well connected to the town system. This is the basis of our interpretation, or for our interpretation of the Brooks Northeast area, and by correlation with the other wells shown outside of our limits, we determined that the other wells were below the gas/water interface. We estimated that to be at minus 890 feet subsea. We think very well of the possibilities and the probabilities of the gas saturation northwest along that structure.

Turning now to Patricia, and at

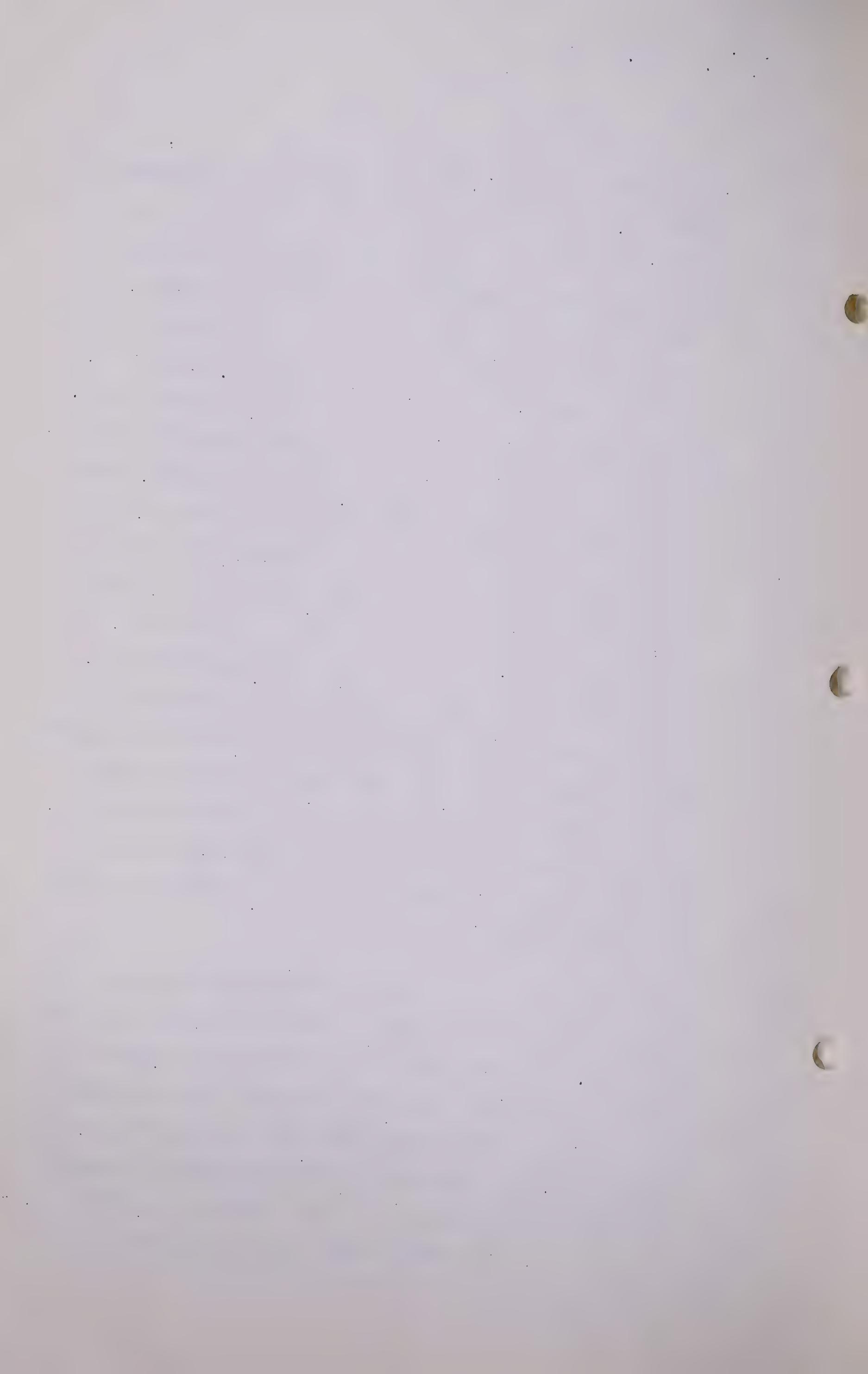


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the back of Sheet 1, Sheet 1B, the Sunburst sand, Map page 27, we have proved gas reserves set out for the Patricia structure. There may be Basal Alberta and Bow Island sands both, but the electrical logs are of the old Halliburton type and not easy to interpret, so that no even possible reserves were assigned to the upper horizons. However, Cal-Standard No. 1-Patricia, Township 20, Range 12, West of the 4th, Section 6, Lsd. 4, has the Sunburst very well developed from 3300 to 3375, the gas/water contact at 3350, minus 890 subsea, the drillstem tests 3297 to 3314 of  $1\frac{1}{2}$  million feet, and 3308 to 3329 up to 2 million cubic feet, 3341 to 3355, 400 feet of gassy oil and water, 3352 to 3362, 107 feet of water, completed as a potential gas well, no record of the well being perforated, core analyses, average porosity 19%, average permeability 500 millidarcies, and it sounds like a very nice well. There are flank possibilities similar to that, and the Sunburst sand waxes and wanes there over quite a considerable area, and the Sunburst has great potentialities but very little real prospecting being done there.

Next, Princess Field proper, and the sand in the stratigraphic column has had gas or oil in it. As you will note from the Bow Island down through the Devonian and the Jefferson limestone, this area was drilled for the Madison and Jefferson oil beginning in 1940. Referring to page 1B, we show the proved, probable and possible reserves for all those horizons from the Basal, from the Bow Island Basal Alberta, Sunburst,



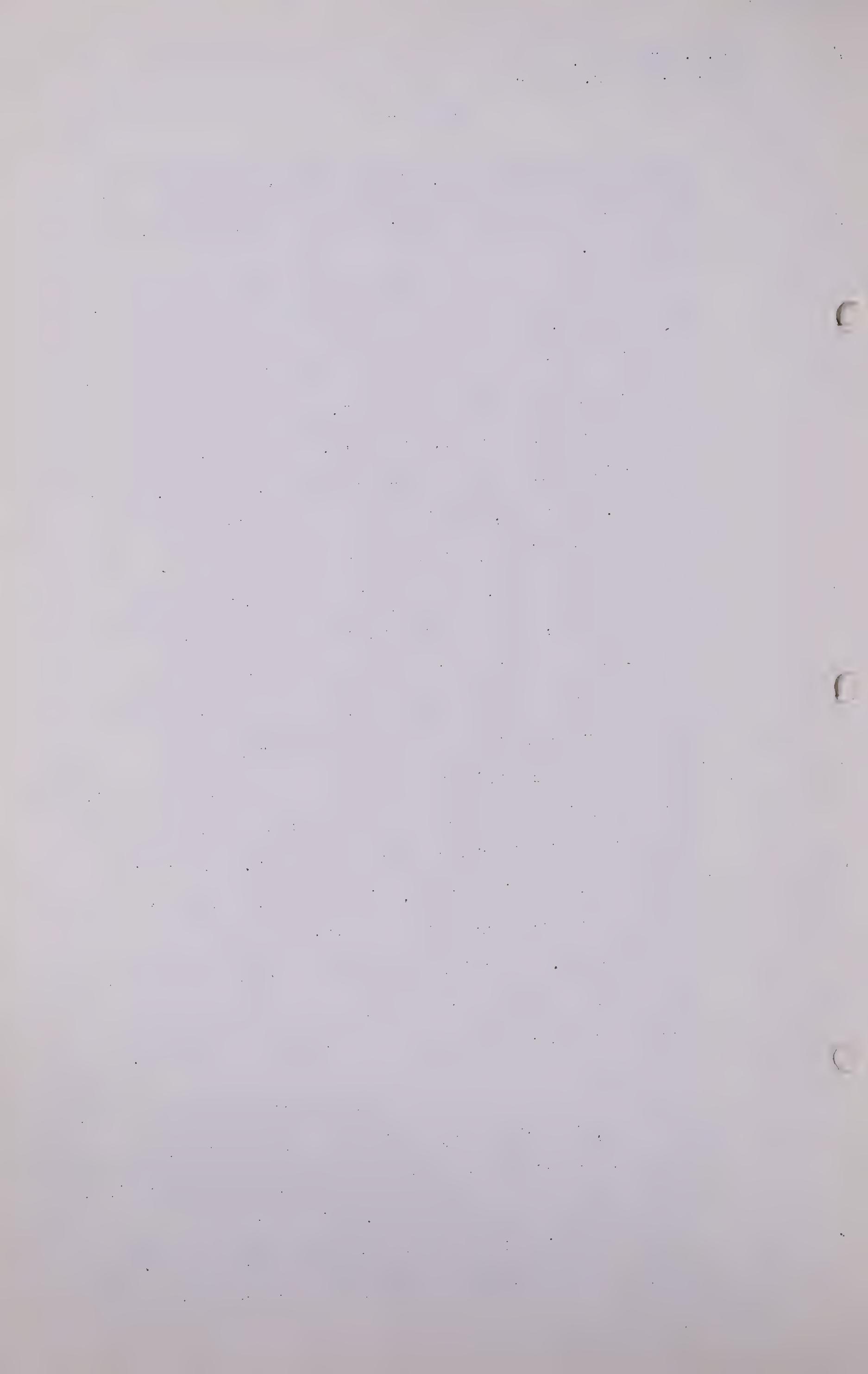
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Madison and Jefferson, with the exception of the Bow Island, we show no proved, they are only probable and possible.

Referring to the Bow Island, Map page 25, we show only possible and probable areas. We think that they may be very extensive. No gas wells were completed in the reservoir, the probable area shown centred in Township 20, Range 12, West of 4, is supported by a drillstem test in Cal-Standard No.2 Brooks, Township 20, Range 12, Section 13, with a drillstem test 2540 to 2560 with 1/2 million cubic feet of gas. The upper 2575 to 2593, the top of the Bow Island sands begin at 2460, and the upper zones were not drillstem tested. We interpret that there are probably 2 to 20 feet of probable gas saturation. 5 tests are shown over the probable area of which 3 we attempted to interpret the electrical logs on the basis of the electrical characteristics as a basis for the possible area and as an additional basis for the probable area. 40 tests inside of the possible area, with 27 analyzed in an attempt to get the approximate indicated thickness of gas saturation. We think considerable drilling and re-testing will be necessary to move any of those areas into the proved and probable category out of the possible.

The Basal Alberta sands, or sand, page Map 26, is drilled by a pinchout of the Basal Alberta sand to the southwest as shown by the dotted line. That is drilled by several wells, drilled along the strike of that line in which no Basal Alberta occurs. However, it does occur on the flank of Princess proper



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and to the northeast.

There are two proved areas supported by the following wells, Cal-Standard No. 64-8 in Township 19 north, Range 11 West of 4, Section 8, Lsd. 6. That is centred around the proved area, and is the southern part of the area shown on the map in Township 19, Range 11-4, and the gas well in the centre of that area is this well. Drillstem tests 2908 to 2935 produced  $3\frac{3}{4}$  million cubic feet, completed as a gas well, however, not in this sand but in the Madison gas cap down below. The north part of the area....

Q That well that you have just been speaking of is in Section 4?

A No, Section 6, in the middle of the heavy dark proved line in Township 19, Range 11.

Q 19-11?

A Yes, page 26.

Q THE CHAIRMAN: It is in Section 8?

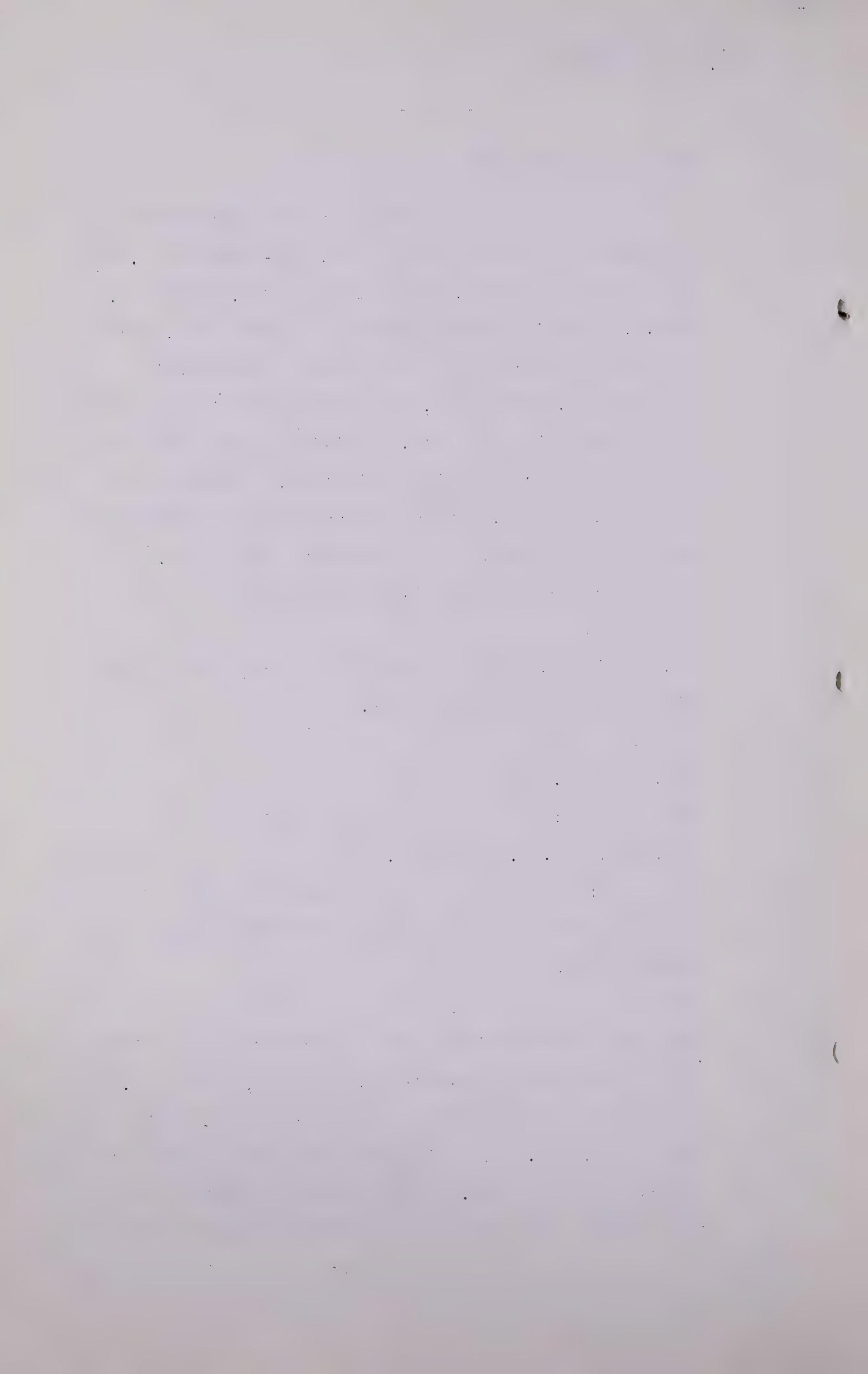
A Yes, sir, Lsd. 6, I believe.

Q MR. STEER: And the number of the well?

A That is a gas well with a 20-foot thickness right in the middle of it.

Q Yes?

A The north area of proved Basal Alberta gas saturation as a reserve is in Township 20, Range 12, West of 4, and that is supported by the Cal-Standard No. 76 in Section 22, Lsd. 12. Drillstem test 2831 to 2854 of 700 cubic feet of gas. That test was carried in the Devonian and was abandoned after failing to get



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Devonian oil in 1940 or thereabouts. The electrical log correlations with that well enabled us to indicate thicknesses ranging from 3 to 11 feet in that area. The probable area which is the long area, the elongated area within the dashed line coming into Princess, inside Princess, and extending down into Township 18, Range 11, West of 4, is supported by several tests. The first is the P.S. & D. Globe No. 1, Township 20, Range 12, West of 4. That would be up in the northern part of the Princess area, Section 3, Lsd. 2, and drilled to 3420 in the Madison, plugged back to 2960, and completed as a potential Basal Alberta gas well. The schedule of wells makes no mention of any test. They say the operations were suspended in December, 1949. Dr. Hume, on page 260 credits that with being a potential gas well. We have not been able to find a specific test, that is, with regard to a drillstem test, but on the electrical log it looks very good. There is probably a gas saturation in some amounts.

Q MR.GOODALL: Is that the only test you have in that area?

A No, sir, we have two other tests in Township 20, Range 12, Section 31.

Q MR. STEER: Excuse me, that P.S.& D. Globe No. 1 that you were talking about a moment ago?

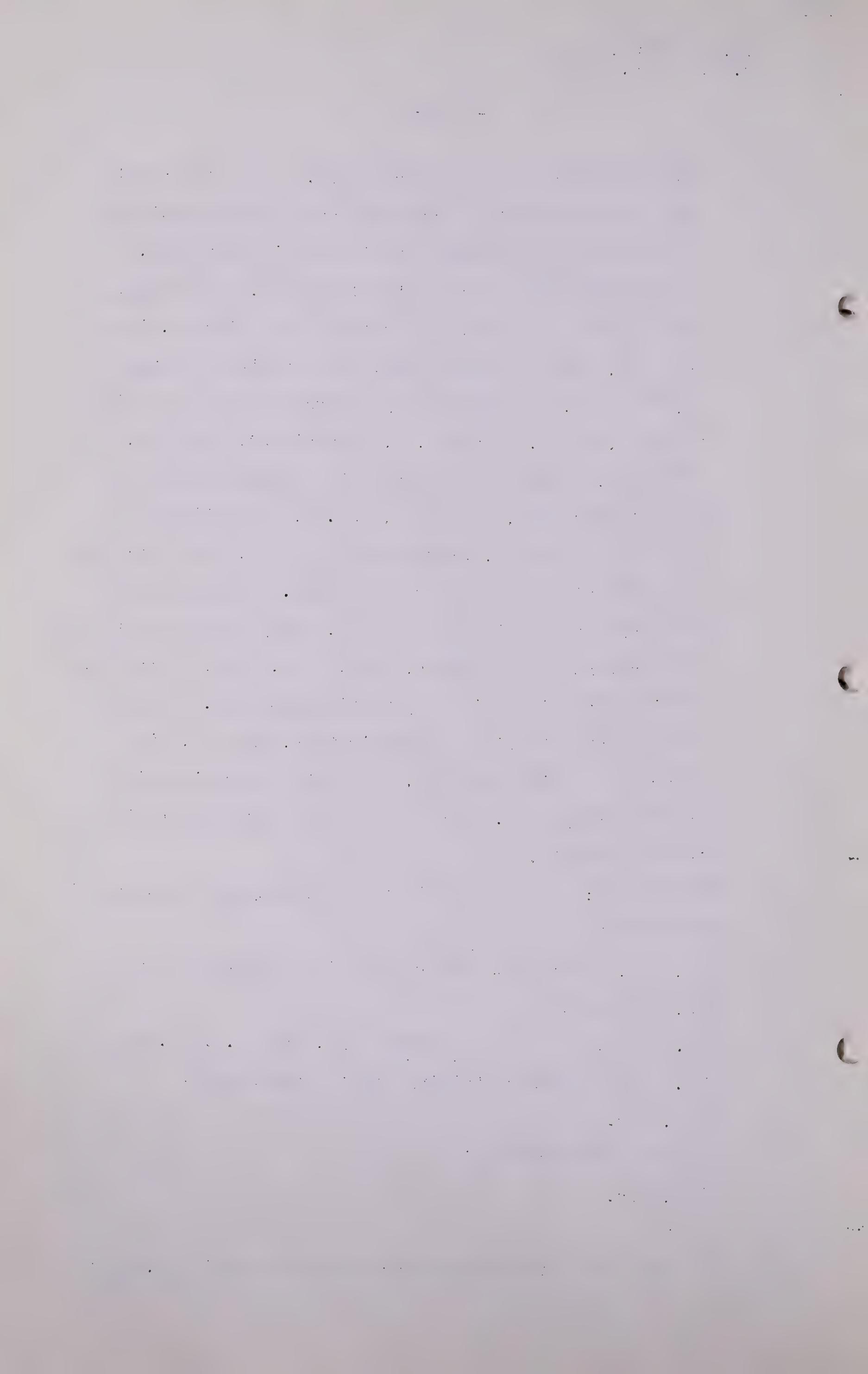
A Yes, sir.

Q That was in Section 3?

A Yes, sir.

Q Yes?

A The last well I made reference to was Township 20, Range



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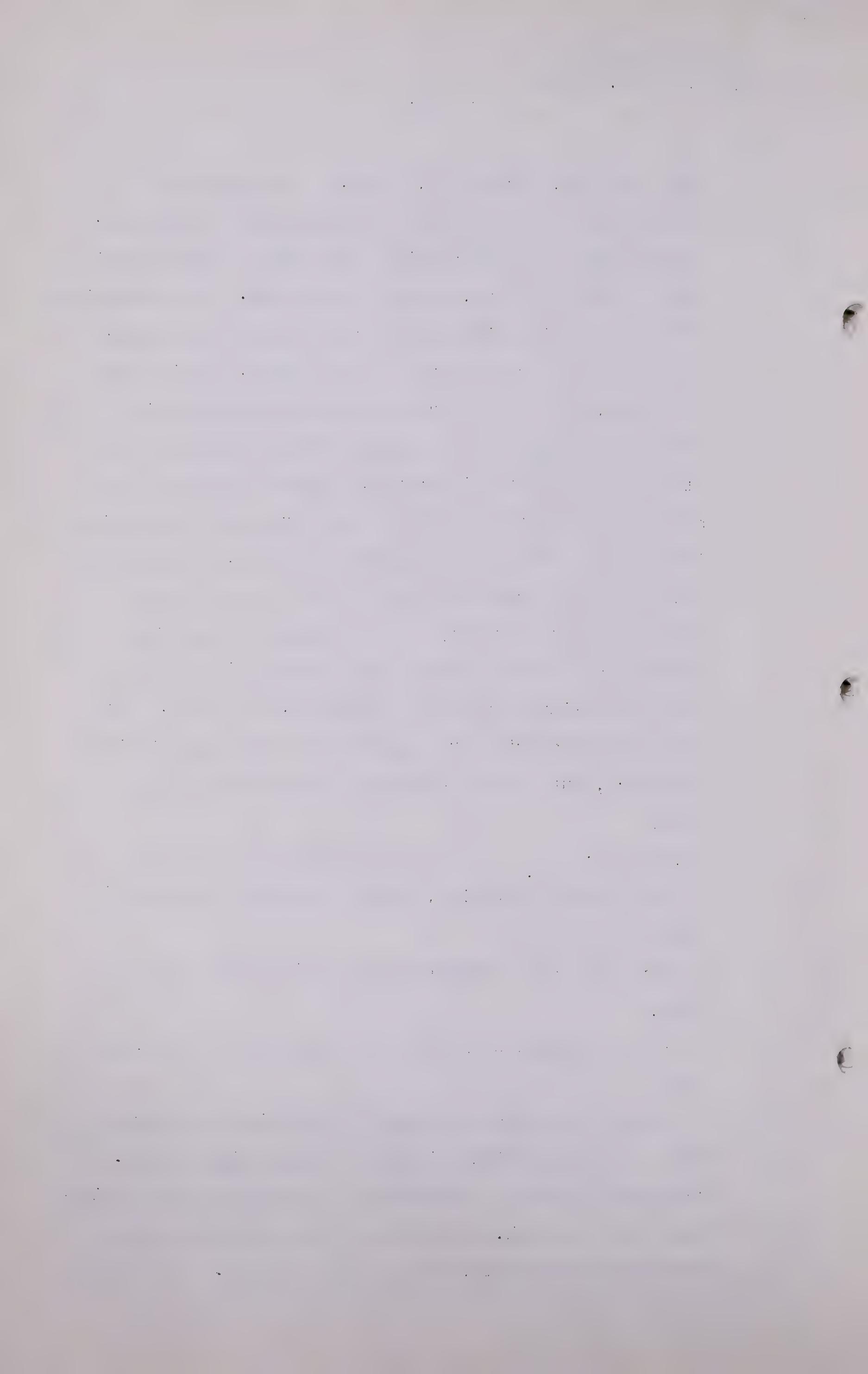
12, West of 4, Section 31, Lsd.9. That well was recorded although it gives no volume that was measured, and we have it in the possible area where the reservoir might extend that far, but we do not know. Our additional test is in Section 13 of that same township and range, and that well recorded gas in some volume, but no gauge was taken, so that we placed it in the probable area because gas saturation is demonstrated. We think it is close to a gas/water interface, and the thickness would probably be limited. In the proved area with electrical logs, on the basis of the control of wells, 6 wells were counted in the probable area, 5 wells in the possible area, and there was only the 1 notation of some gas between the pinchout of the sand and what is indicated as an approximate gas/water interface. The east, north and south boundaries are supported by that good gas/water interface, but the west boundary has a pinchout of the sand.

Q MR.GOODALL: Is the gas/water interface all in the same elevation, or were you able to follow it through?

A We have made the assumption that it is at that probable area.

Q Is it an assumption or have you found that by drillstem tests?

A We have in drillstem tests and by electrical log correlation. What I hope to indicate is that it holds fairly well. We interpret that from a combination of structural and drillstem test control. That is why we have indicated that as being highly probable, but not quite proved.



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Q But it is together in that zone?

A Yes, that is quite right.

MR. C. E. SMITH: I wonder if a quarter to one o'clock comes into the probable classification, seeing as we started at nine o'clock this morning?

THE CHAIRMAN: Just a minute, Mr. Smith.

Q Are you just about through with this portion, Mr. Dougherty?

A Yes, sir, I think that covers that.

THE CHAIRMAN: Well, we will adjourn until tomorrow morning then.

(Hearing adjourned until 9.30 A.M., September 19th, 1951)

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# The Province of Alberta

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## PETROLEUM AND NATURAL GAS CONSERVATION BOARD

Application for Permission to Remove or cause to be removed  
Natural Gas from the Province of Alberta, under the Provisions of the  
Gas Resources Preservation Act by Western Pipe Lines.

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I. N. McKinnon Esq., Chairman

D. P. Goodall Esq.

Dr. G. W. Govier

*Session:*

Volume \_\_\_\_\_

